ENGINE MECHANICAL

SECTION EM

MODIFICATION NOTICE:

- VG33E engine has been introduced for Australia.
- A/T models with QD32 engine have been introduced for Latin America. For information not included here, refer to information for QD32 engine in D22 series Supplement-II Service Manual (Pub. No. SM9E-D22BG0).

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VG33E

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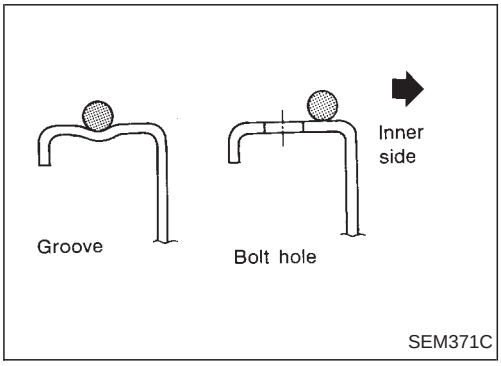
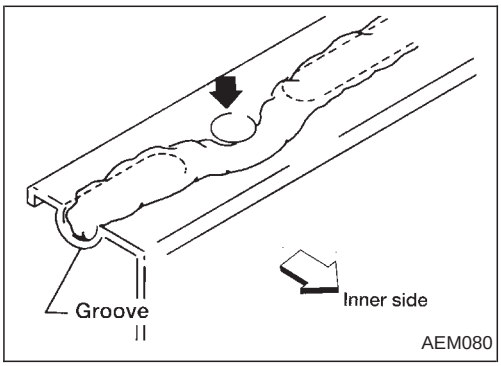
Parts Requiring Angular Tightening

- Use an angle wrench for the final tightening of the following engine parts:
  (1) Cylinder head bolts
  (2) Connecting rod cap nuts
- Do not use a torque value for final tightening.
- The torque value for these parts are for a preliminary step.
- Ensure thread and seat surfaces are clean and coated with engine oil.





Liquid Gasket Application Procedure

a. Use a scraper to remove all traces of old liquid gasket from mating surfaces and grooves. Also completely clean any oil stains from these portions.

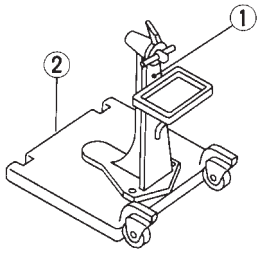
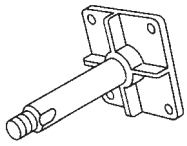
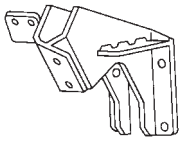
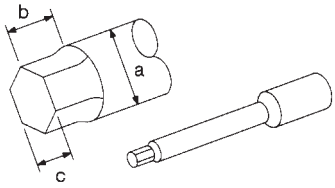
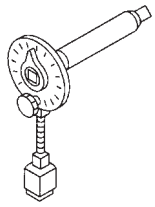
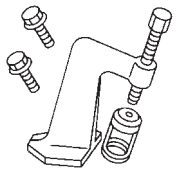
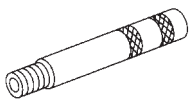
b. Apply a continuous bead of liquid gasket to mating surfaces. (Use Genuine Liquid Gasket or equivalent.)
- **Be sure liquid gasket is 3.5 to 4.5 mm (0.138 to 0.177 in) dia. (for oil pan).**
- **Be sure liquid gasket is 2.0 to 3.0 mm (0.079 to 0.118 in) dia. (in areas except oil pan).**

c. Apply liquid gasket to inner surface around hole perimeter area (unless otherwise specified).

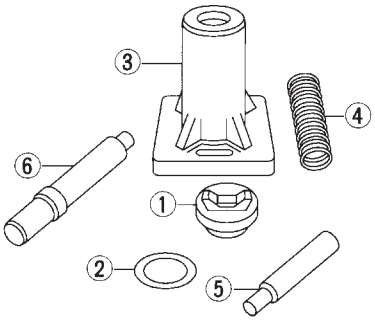
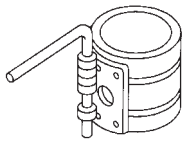
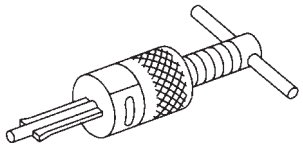
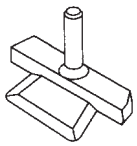
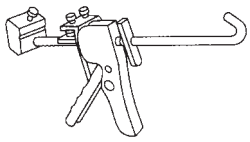
d. Assembly should be done within 5 minutes after coating.

e. Wait at least 30 minutes before refilling engine oil and engine coolant.

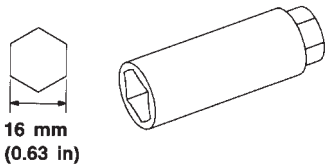
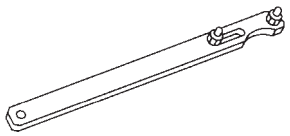
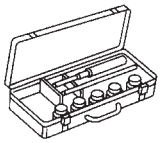
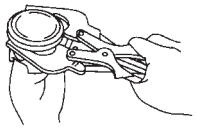
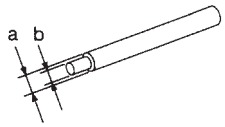
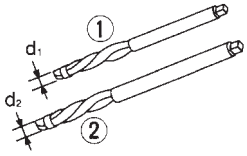
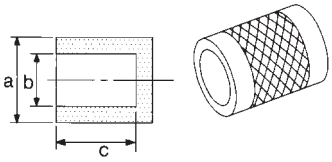
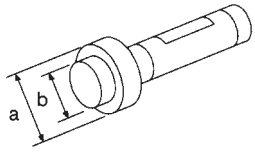
Special Service Tools

Tool number Tool name	Description
ST0501S000 Engine stand assembly ① ST05011000 Engine stand ② ST05012000 Base	Disassembling and assembling  NT042
KV10106500 Engine stand shaft	 NT028
KV10110001 Engine sub-attachment	 NT032
ST10120000 Cylinder head bolt wrench	Loosening and tightening cylinder head bolt  NT583 **a: 13 (0.51) dia.** **b: 12 (0.47)** **c: 10 (0.39)** Unit: mm (in)
KV10112100 Angle wrench	Tightening bearing cap, cylinder head bolts, etc.  NT014
KV10110600 Valve spring compressor	Disassembling and assembling valve components  NT033
KV10107501 Valve oil seal drift	Installing valve oil seal  NT025

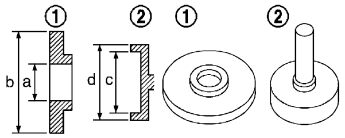
Special Service Tools (Cont'd)

Tool number Tool name	Description	
KV10110300 Piston pin press stand assembly ① KV10110310 Cap ② KV10110330 Spacer ③ ST13030020 Press stand ④ ST13030030 Spring ⑤ KV10110340 Drift ⑥ KV10110320 Center shaft	 NT036	Disassembling and assembling piston with connecting rod
EM03470000 Piston ring compressor	 NT044	Installing piston assembly into cylinder bore
ST16610001 Pilot bushing puller	 NT045	Removing crankshaft pilot bushing
KV10111100 Seal cutter	 NT046	Removing oil pan
WS39930000 Tube presser	 NT052	Pressing the tube of liquid gasket

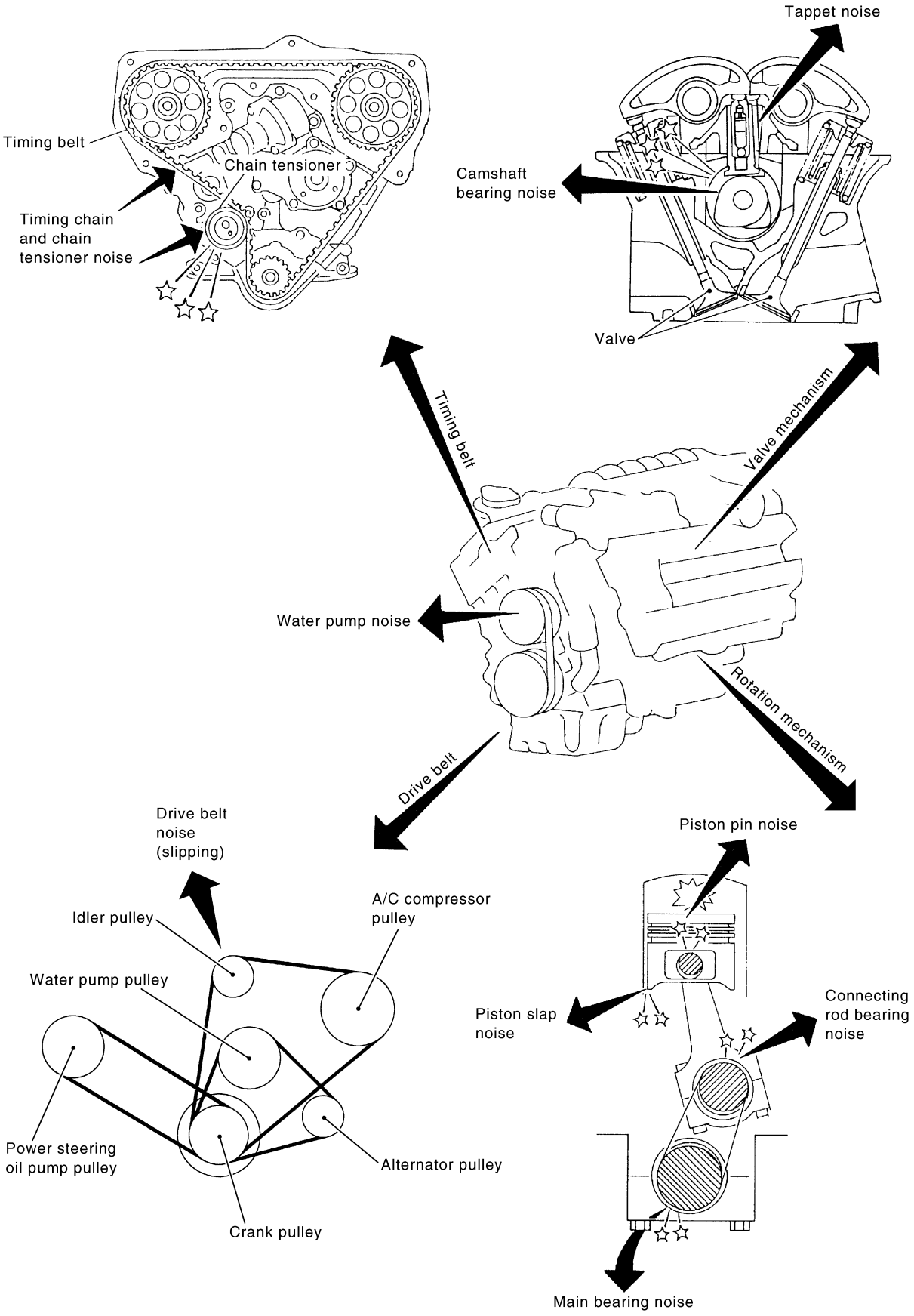
Commercial Service Tools

Tool name	Description	
Spark plug wrench	NT047 	Removing and installing spark plug
Pulley holder	NT035 	Holding camshaft pulley while tightening or loosening camshaft bolt
Valve seat cutter set	NT048 	Finishing valve seat dimensions
Piston ring expander	NT030 	Removing and installing piston ring
Valve guide drift	NT015 	Removing and installing valve guide Diameter mm (in) Intake: a = 10.5 (0.413); Exhaust: a = 10.5 (0.413) Intake: b = 6.6 (0.260); Exhaust: b = 6.6 (0.260)
Valve guide reamer	NT016 	Reaming valve guide ① or hole for oversize valve guide ② **Intake:** **d_1 = 7.0 mm (0.276 in) dia.** **d_2 = 11.2 mm (0.441 in) dia.** **Exhaust:** **d_1 = 8.0 mm (0.315 in) dia.** **d_2 = 12.2 mm (0.480 in) dia.**
Camshaft oil seal drift	NT613 	Installing camshaft oil seal **a: 60 mm (2.36 in) dia.** **b: 44.5 mm (1.752 in) dia.** **c: 75 mm (2.95 in)**
Front oil seal drift	NT049 	Installing front oil seal **a: 52 mm (2.05 in) dia.** **b: 44 mm (1.73 in) dia.**

Commercial Service Tools (Cont'd)

Tool name	Description	
Rear oil seal drift	 WEM152	Installing rear oil seal **a: 46 mm (1.81 in)** **b: 110 mm (4.33 in)** **c: 84 mm (3.31 in)** **d: 96 mm (3.78 in)**

Noise, Vibration and Harshness (NVH)



SEM141H

Noise, Vibration and Harshness (NVH) (Cont'd)

NVH TROUBLESHOOTING CHART — ENGINE NOISE

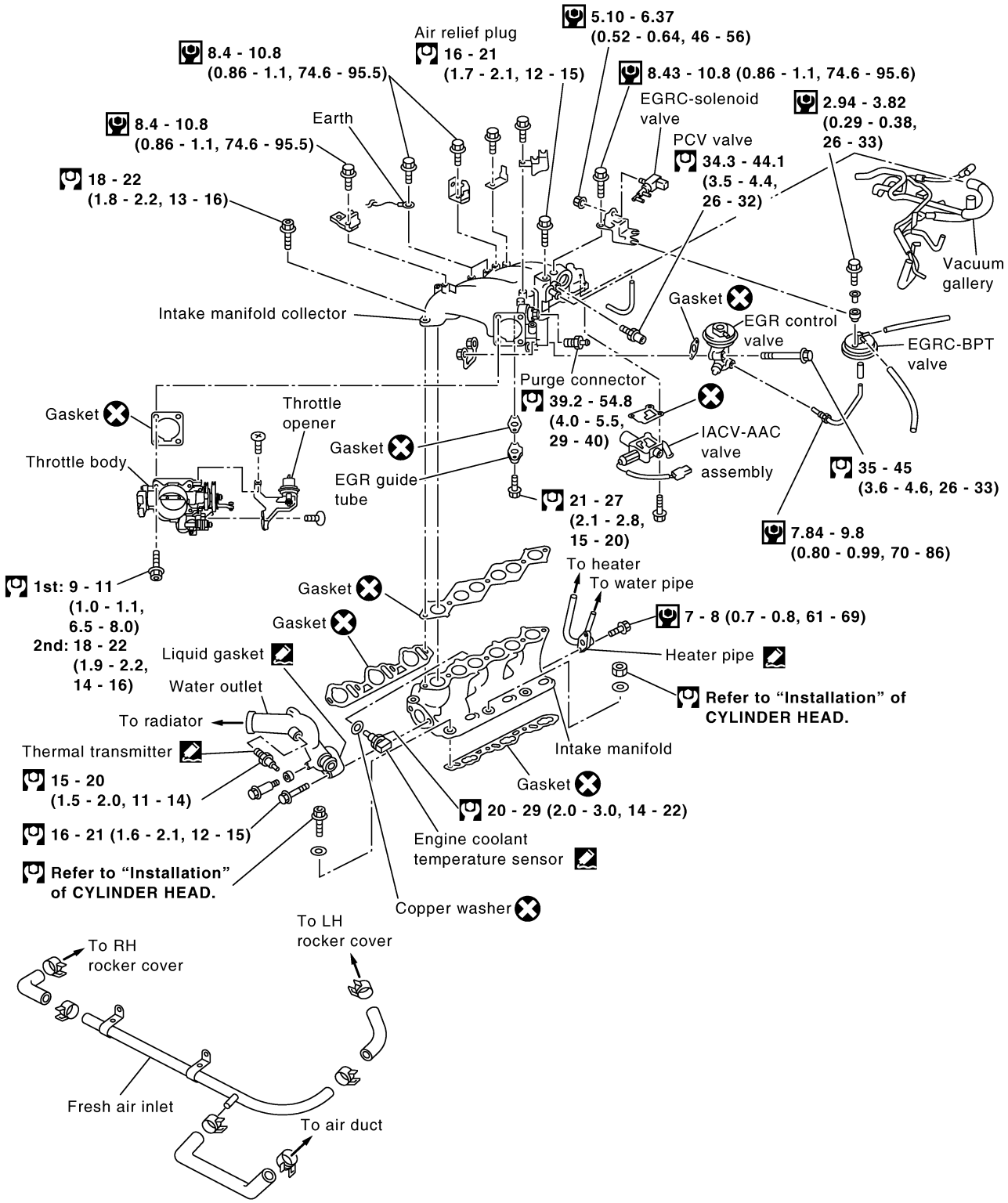
Use the chart below to help you find the cause of the symptom.

1. Locate the area where noise occurs.
2. Confirm the type of noise.
3. Specify the operating condition of engine.
4. Check specified noise source. If necessary, repair or replace these parts.

Location of noise	Type of noise	Operating condition of engine						Source of noise	Check item	Reference page
		Before warm-up	After warm-up	When starting	When idling	When racing	While driving			
Top of engine Rocker cover Cylinder head	Ticking or clicking	C	A	—	A	B	—	Tappet noise	Hydraulic valve lifter	EM-39
	Rattle	C	A	—	A	B	C	Camshaft bearing noise	Camshaft journal clearance Camshaft runout	EM-35 EM-34
Crankshaft pulley Cylinder block (Side of engine) Oil pan	Slap or knock	—	A	—	B	B	—	Piston pin noise	Piston and piston pin clearance Connecting rod bushing clearance (Small end)	EM-49 EM-56
	Slap or rap	A	—	—	B	B	A	Piston slap noise	Piston-to-bore clearance Piston ring side clearance Piston ring end gap Connecting rod bend and torsion	EM-51 EM-50 EM-50 EM-50
	Knock	A	B	C	B	B	B	Connecting rod bearing noise	Connecting rod bushing clearance (Small end) Connecting rod bearing clearance (Big end)	EM-56 EM-55
	Knock	A	B	—	A	B	C	Main bearing noise	Main bearing oil clearance Crankshaft runout	EM-53 EM-53
Timing belt cover	Whine or hissing	C	A	—	A	A	—	Timing belt noise (too tight)	Loose timing belt Belt contacting case	EM-20
	Clatter	A	B	—	C	A	—	Timing belt noise (too loose)		
Front of engine	Squeaking or fizzing	A	B	—	B	—	C	Other drive belts (Sticking or slipping)	Drive belts deflection	MA section ("Checking Drive Belts")
	Creaking	A	B	A	B	A	B	Other drive belts (Slipping)	Idler pulley bearing operation	
	Squall Creak	A	B	—	B	A	B	Water pump noise	Water pump operation	LC section ("Water Pump")

A: Closely related B: Related C: Sometimes related —: Not related

SEC. 140•147•148•163



: Always replace after every disassembly.

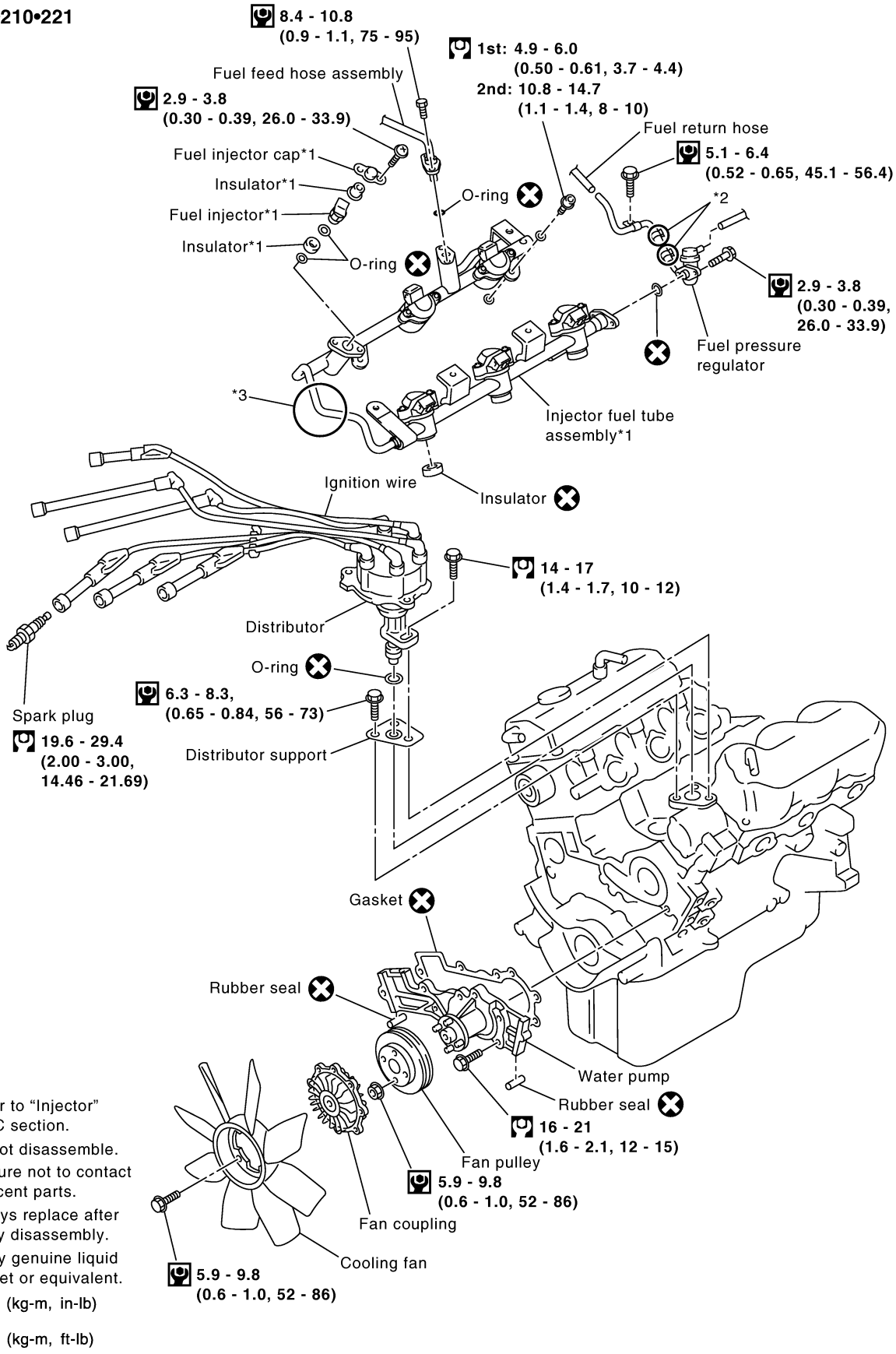
: Apply genuine liquid gasket or equivalent.

: N•m (kg-m, in-lb)

: N•m (kg-m, ft-lb)

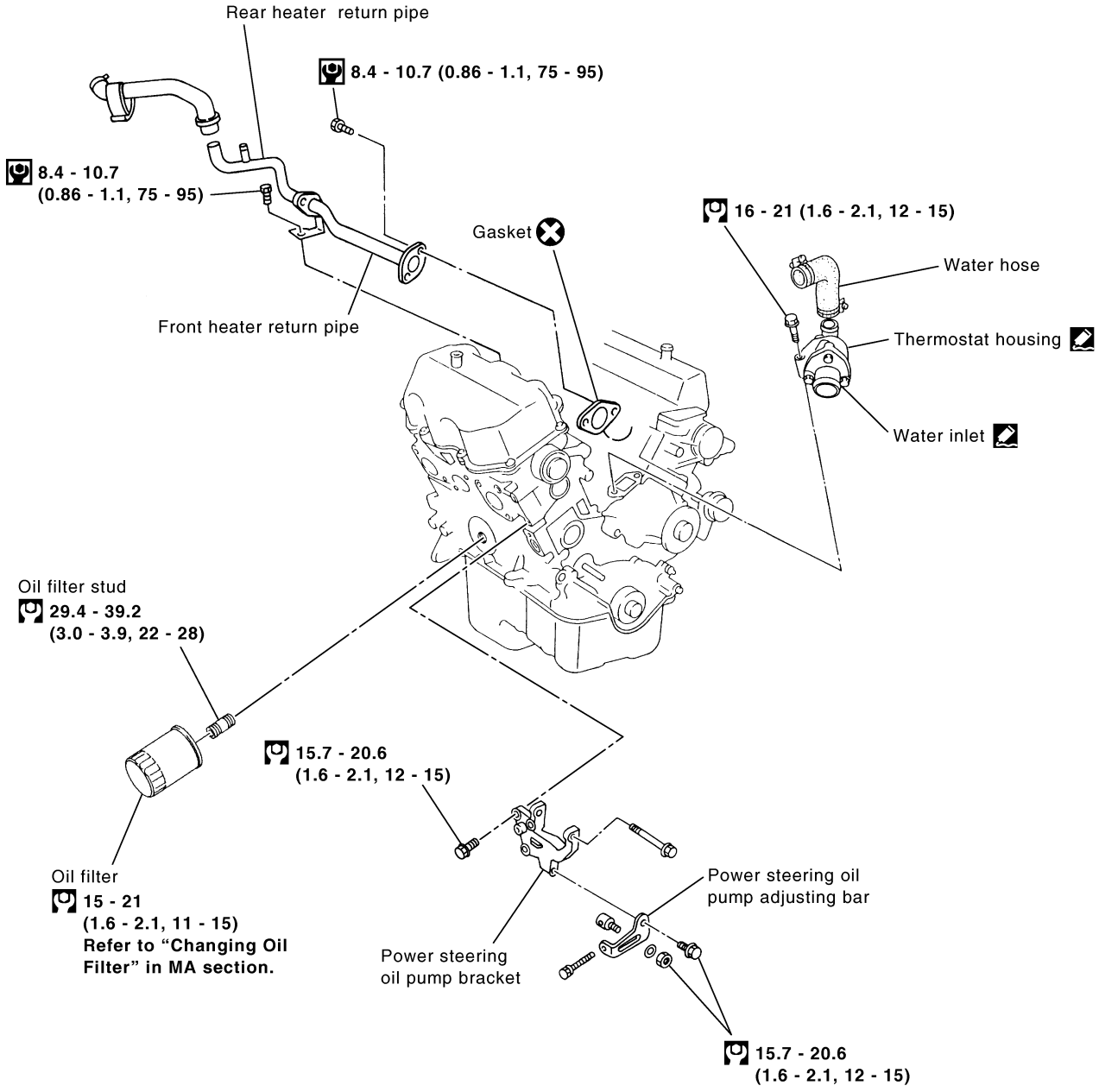
SEM082H

SEC. 164•210•221



*1 : Refer to "Injector" in EC section.
*2 : Do not disassemble.
*3 : Be sure not to contact adjacent parts.
: Always replace after every disassembly.
: Apply genuine liquid gasket or equivalent.
: N•m (kg-m, in-lb)
: N•m (kg-m, ft-lb)

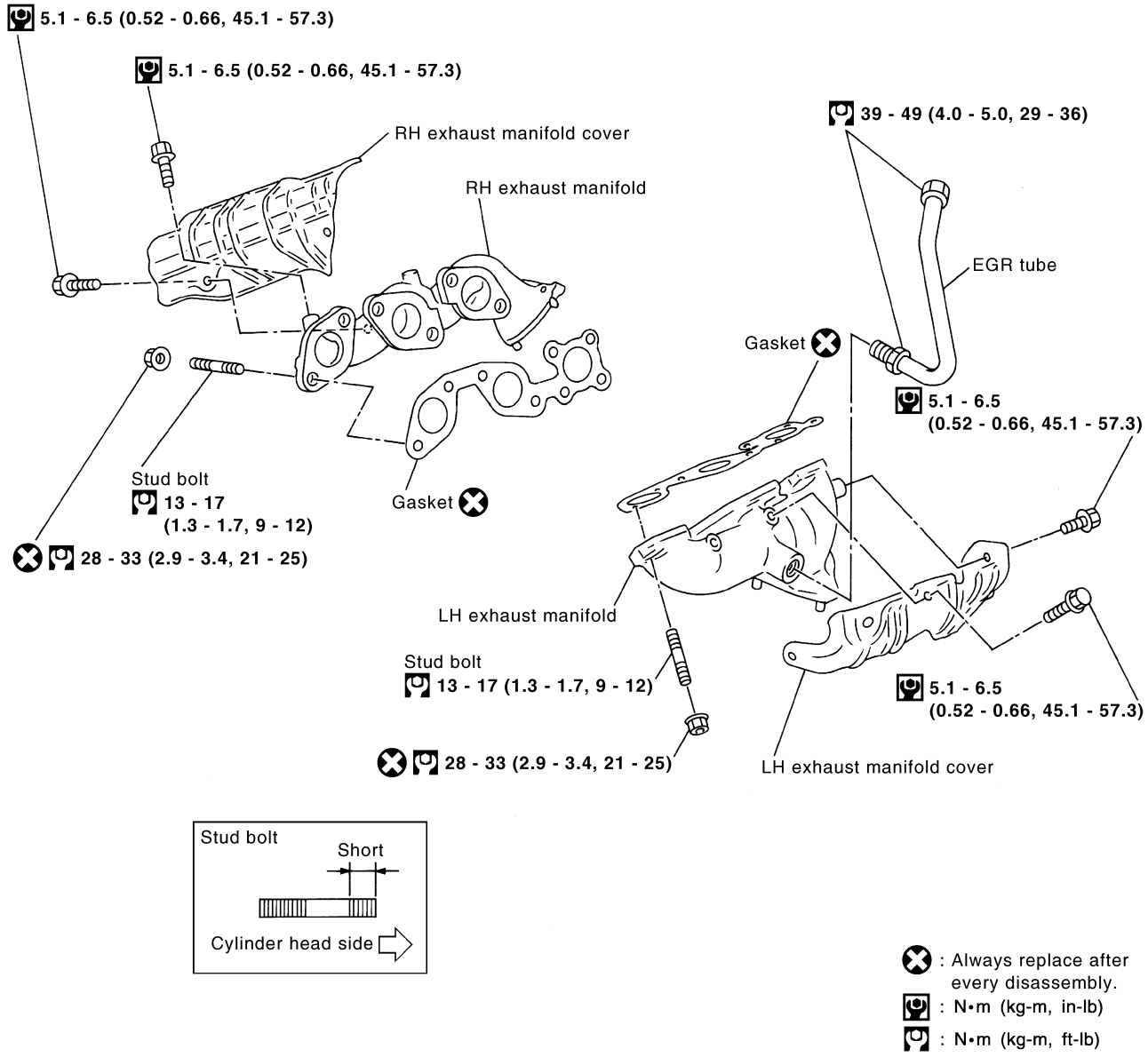
SEM136H



: Apply genuine liquid gasket or equivalent.
: Always replace after every disassembly.
: N•m (kg-m, in-lb)
: N•m (kg-m, ft-lb)

SEM147H

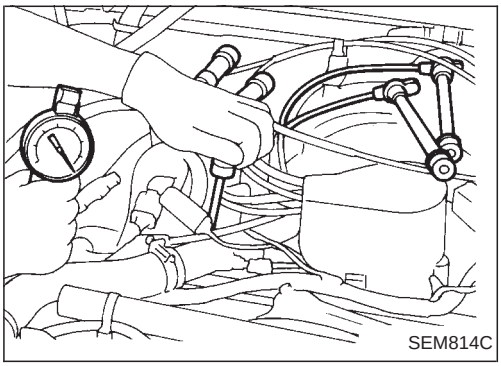
SEC. 140



SEM307FA

Measurement of Compression Pressure

1. Warm up engine.
2. Turn ignition switch off.
3. Release fuel pressure.
   Refer to procedure without CONSULT-II of “Releasing Fuel Pressure” in EC section.
- **Remove fuel pump fuse until the end of step 10.**
4. Remove all spark plugs.
- Clean the area around plug with compressed air before removing the spark plug.
5. Disconnect the camshaft position sensor harness connector at the distributor.


SEM814C

20 mm (0.79 in) dia.

Use compressor tester whose end (rubber portion) is less than 20 mm (0.79 in) dia. Otherwise, it may be caught by cylinder head during removal.

SEM387C

6. Attach a compression tester to No. 1 cylinder.
7. Depress accelerator pedal fully to keep throttle valve wide open.
8. Crank engine and record highest gauge indication.
9. Repeat the measurement on each cylinder as shown above.
- **Always use a fully-charged battery to obtain specified engine speed.**

Compression pressure: kPa (bar, kg/cm^2, psi)/300 rpm

Standard

1,196 (11.96, 12.2, 173)

Minimum

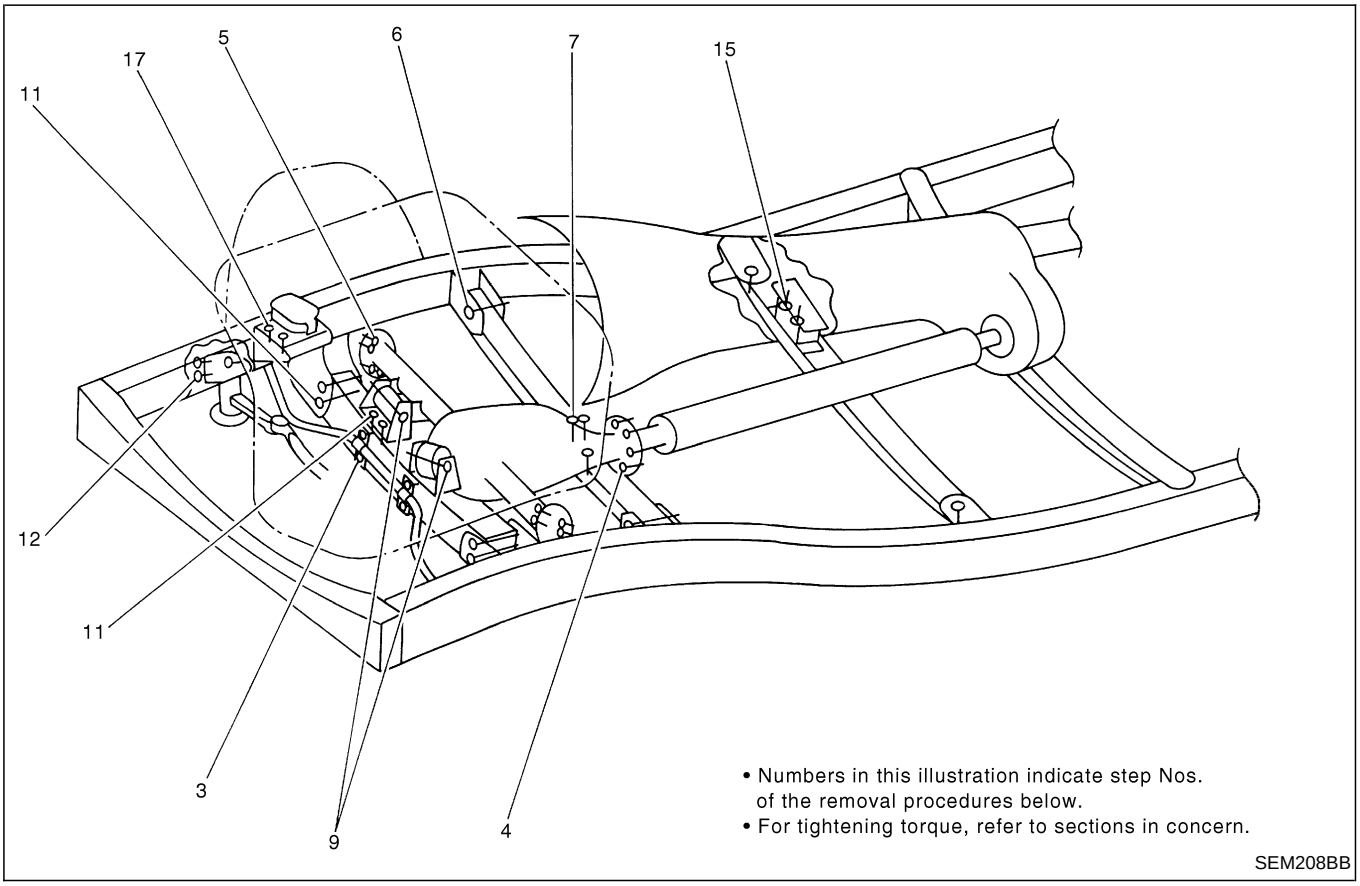
883 (8.83, 9.0, 128)

Difference limit between cylinders

98 (0.98, 1.0, 14)

10. If cylinder compression in one or more cylinders is low, pour a small amount of engine oil into cylinders through spark plug holes and retest compression.
- **If adding oil improves cylinder compression, piston rings may be worn or damaged. If so, replace piston rings after checking piston.**
- **If pressure stays low, a valve may be sticking or seating improperly. Inspect and repair valve and valve seat. (Refer to SDS.) If valve or valve seat is damaged excessively, replace them.**
- **If compression in any two adjacent cylinders is low and if adding oil does not improve compression, there is leakage past the head gasket surface. If so, replace cylinder head gasket.**
11. Install removed parts in reverse order of removal.

Removal



WARNING:

- **Place vehicle on a flat and solid surface.**
- **Place chocks at front and rear of rear wheels.**
- **You should not remove oil pan until exhaust system and cooling system have completely cooled off.**
  Otherwise, you may burn yourself and/or fire may break out in the fuel line.
- **When remove front and/or rear engine mounting bolts or nuts, lift up slightly engine for safety work.**

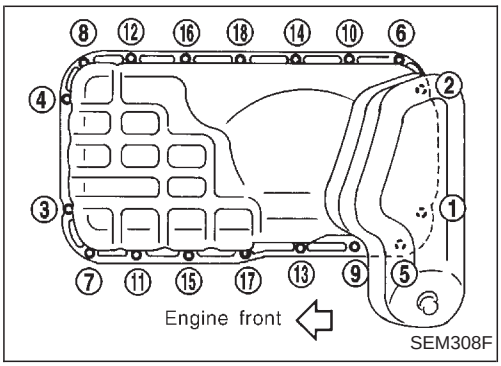
CAUTION:

- **In lifting engine, be careful not to hit against adjacent parts, especially against accelerator wire casing end, brake tube and brake master cylinder.**
- **For tightening torque, refer to specified sections.**

1. Remove undercover.
2. Drain engine oil. Refer to “Changing Engine Oil” in MA section.
3. Remove stabilizer bar. Refer to FA section in original Service Manual.
4. Remove front propeller shaft from front differential carrier. Refer to PD section in original Service Manual.
5. Remove front drive shaft fixing bolts (RH & LH). Refer to FA section in original Service Manual.
6. Support front differential carrier and remove front differential carrier member bolts (RH & LH). Refer to PD section in original Service Manual.
7. Remove front differential carrier fixing bolts. Refer to PD section in original Service Manual.

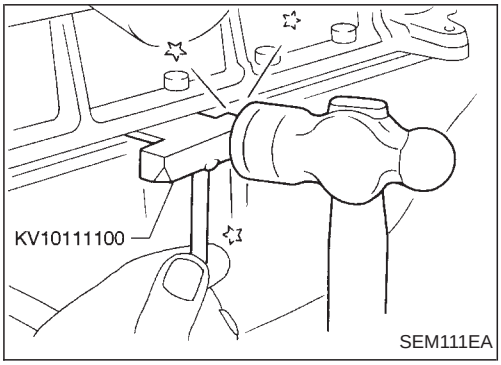
Removal (Cont'd)

8. Remove front differential carrier bleeder hose. Refer to PD section in original Service Manual.
9. Remove differential front mounting bolts (RH & LH). Refer to PD section in original Service Manual.
10. Remove front differential carrier. Refer to PD section in original Service Manual.
11. Remove front differential carrier mounting bracket. Refer to PD section in original Service Manual.
12. Remove idler arm. Refer to ST section in original Service Manual.
13. Remove starter motor. Refer to EL section in original Service Manual.
14. Hoist engine with engine slingers and support transmission with transmission jack. Refer to EM-46, "ENGINE REMOVAL" and MT section.
15. Remove transmission to rear engine mounting bracket nuts (RH & LH). Refer to EM-46, "ENGINE REMOVAL".
16. Remove engine mounting bolts or nuts (RH & LH). Refer to EM-46, "ENGINE REMOVAL".
17. Remove engine gussets. Refer to EM-46, "ENGINE REMOVAL".
18. Lift up engine. Refer to EM-46, "ENGINE REMOVAL".
    If necessary, disconnect exhaust tube. Refer to "Exhaust System" in FE section.



SEM308F

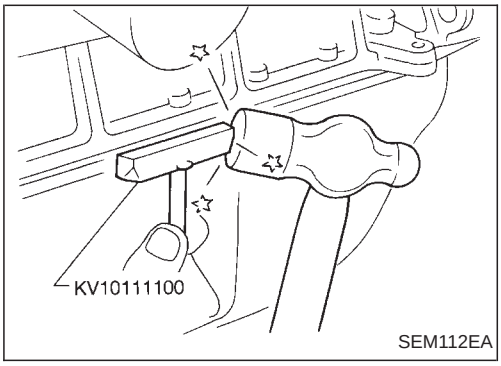
19. Loosen oil pan bolts in numerical order as shown in the figure.



SEM111EA

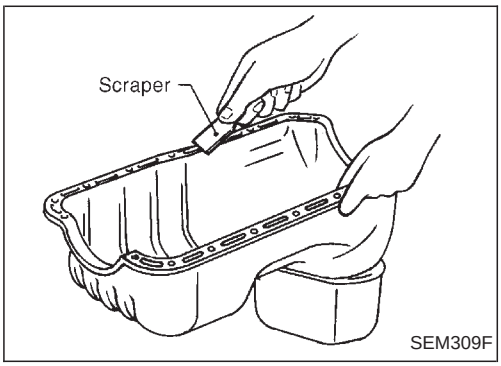
20. Remove oil pan.
(1) Insert seal cutter (SST) between cylinder block and oil pan.

- **Do not drive seal cutter into oil pump or rear oil seal retainer portion, or aluminum mating face will be damaged.**
- **Do not insert screwdriver, or oil pan flange will be deformed.**



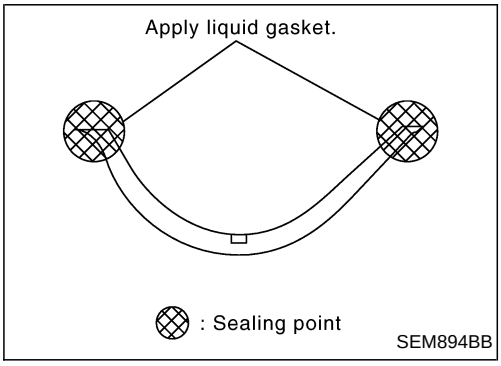
SEM112EA

(2) Slide Tool by tapping its side with a hammer, and remove oil pan.

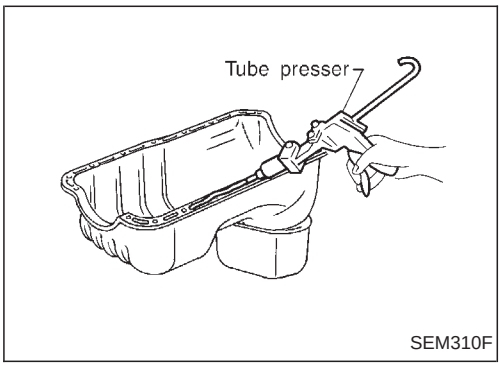


Installation

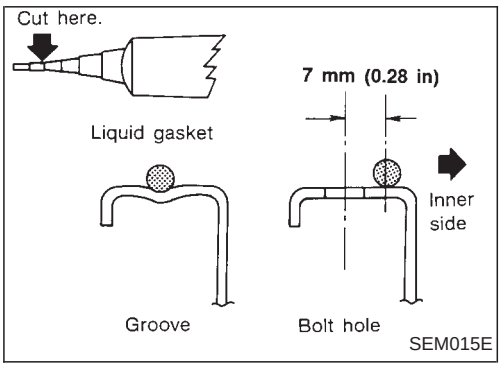
1. Before installing oil pan, remove all traces of liquid gasket from mating surface using a scraper.
- Also remove traces of liquid gasket from mating surface of cylinder block.



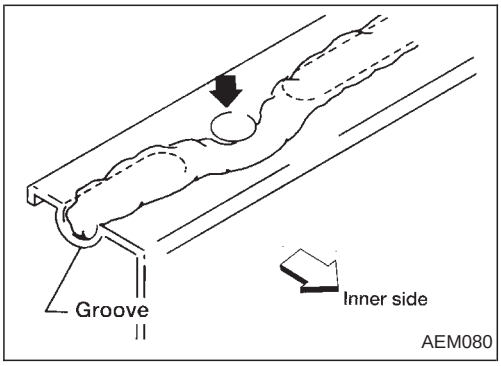
2. Apply liquid gasket to oil pan gasket and rear oil seal retainer gasket.
- **Use Genuine Liquid Gasket or equivalent.**



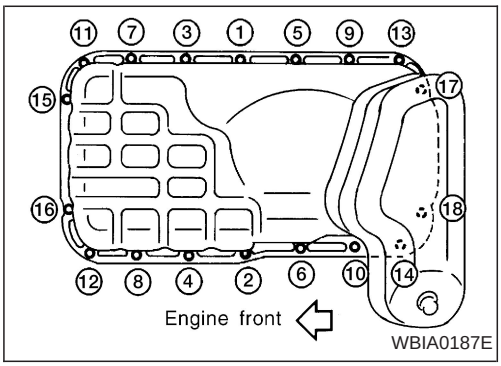
3. Apply a continuous bead of liquid gasket to mating surface of oil pan using tube presser (SST: WS39930000).
- **Use Genuine Liquid Gasket or equivalent.**



- **Be sure liquid gasket is 3.5 to 4.5 mm (0.138 to 0.177 in) wide.**
4. Apply liquid gasket to inner sealing surface as shown in figure.



Installation (Cont'd)



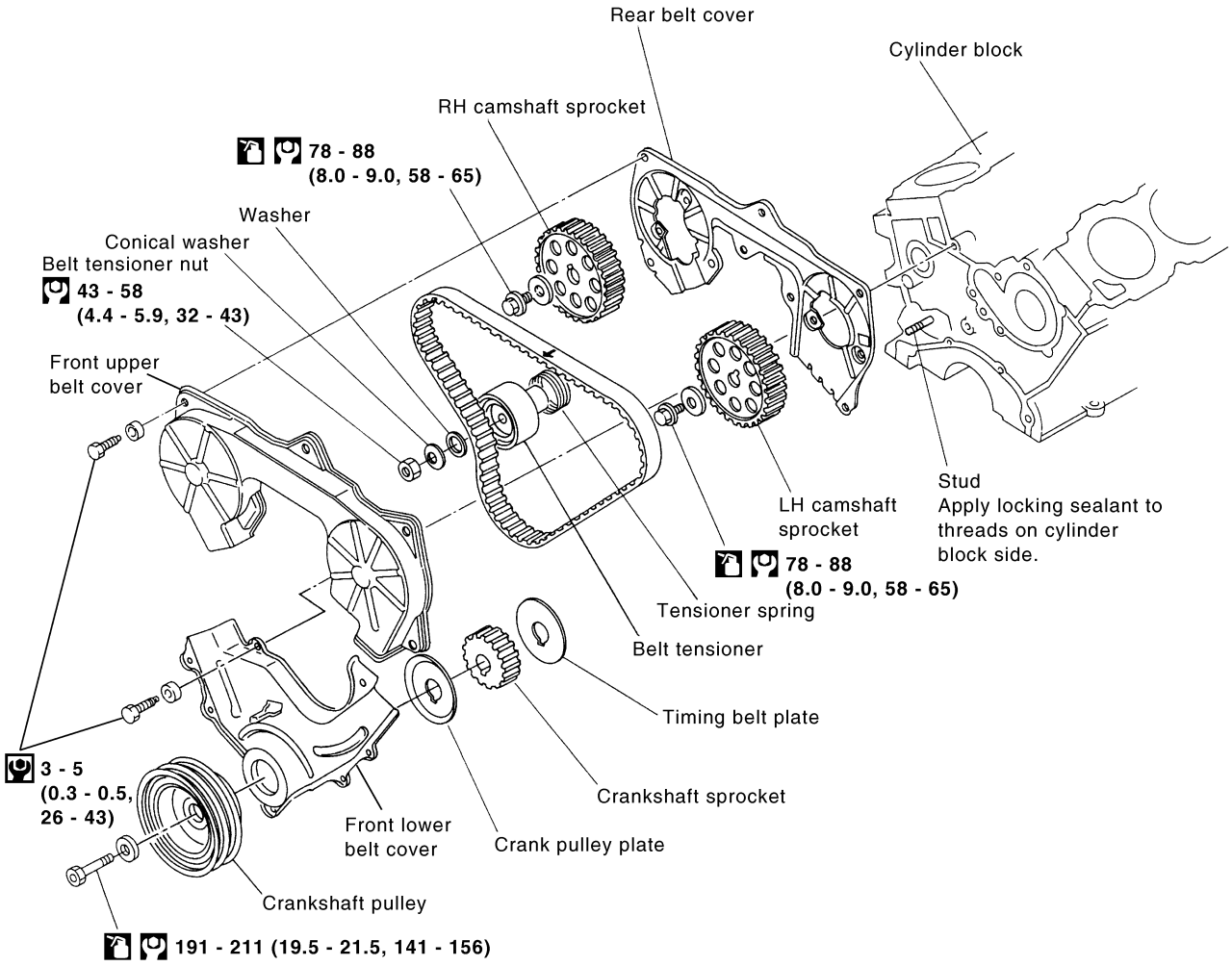
5. Install the oil pan.
   Tighten the oil pan bolts to specification in numerical order as shown in the figure.
- **Attaching should be done within 5 minutes after coating.**
- **Wait at least 30 minutes before refilling engine oil.**

6. Install remaining parts in reverse order of removal.

CAUTION:

a. Do not bend or twist timing belt.
b. After removing timing belt, do not turn crankshaft and camshaft separately because valves will strike piston heads.
c. Make sure that timing belt, camshaft sprocket, crankshaft sprocket and belt tensioner are clean and free from oil and water.
d. Installation should be carried out when engine is cold.

SEC. 120•130•135



: N•m (kg-m, in-lb)

: N•m (kg-m, ft-lb)

: Lubricate with new engine oil.

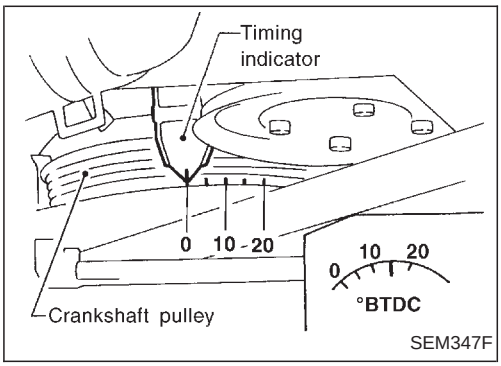
SEM311FB

Removal

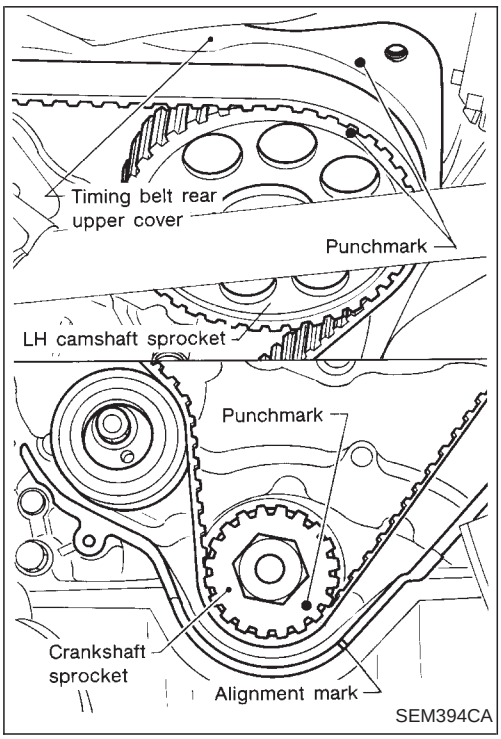
1. Remove engine under cover.
2. Drain engine coolant from radiator. Refer to “Changing Engine Coolant” in MA section.

Be careful not to spill engine coolant on drive belts.

3. Remove radiator. Refer to “Radiator” in LC section.
4. Remove engine cooling fan and water pump pulley. Refer to “Cooling Fan” in LC section.
5. Remove the following belts. Refer to “Checking Drive Belts” in MA section.
- Power steering pump drive belt
- Compressor drive belt
- Alternator drive belt
6. Remove all spark plugs.
7. Remove distributor protector.
8. Remove compressor drive belt idler bracket.
9. Disconnect fresh-air intake tube for rocker cover.
10. Disconnect water hose for thermostat housing.

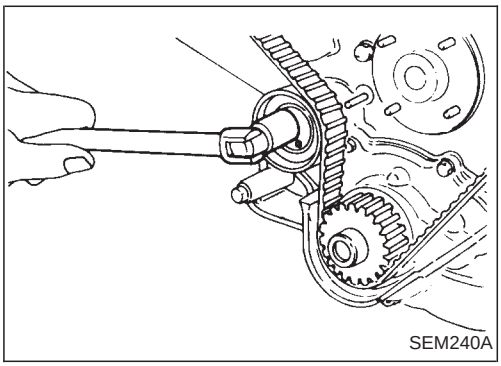


11. Set No. 1 piston at TDC on its compression stroke by rotating crankshaft.
12. Remove crankshaft pulley bolt.
13. Remove crankshaft pulley with a suitable puller.
14. Remove front upper and lower belt covers.



15. Align the camshaft and crankshaft sprockets to the timing marks on the rear belt cover and oil pump body.
- **Align punchmark on LH camshaft sprocket with punchmark on timing belt rear upper cover.**
- **Align punchmark on crankshaft sprocket with the alignment mark on oil pump housing.**
- **Temporarily install crank pulley bolt on crankshaft so that crankshaft can be rotated.**

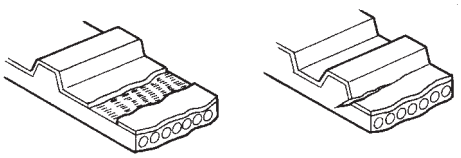
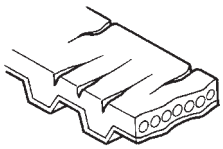
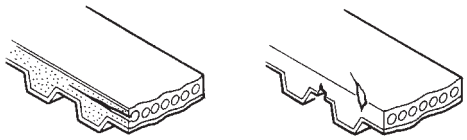
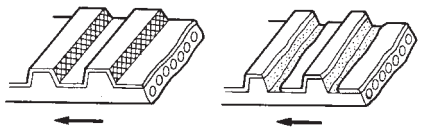
Removal (Cont'd)


SEM240A

16. Loosen timing belt tensioner nut, turn tensioner, then remove timing belt.

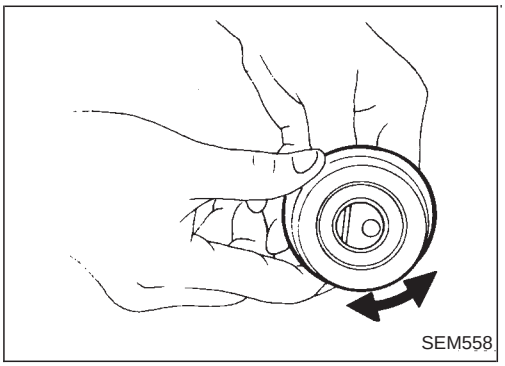
Inspection

Visually check the condition of timing belt.
Replace if any abnormality is found.

Symptom	Problem	Cause
Tooth is broken/tooth root is cracked.	 SEM394A	● Camshaft jamming ● Distributor jamming ● Damaged camshaft/crankshaft oil seal
Back surface is cracked/ worn.	 SEM395A	● Tensioner jamming ● Overheated engine ● Interference with belt cover
● Side surface is worn. ● Belt corners are worn and round. ● Wicks are frayed and coming out.	 SEM396A	● Improper installation of belt ● Malfunctioning crankshaft pulley plate/timing belt plate
● Teeth are worn. ● Canvas on tooth face is worn down. ● Canvas on tooth is fluffy, rubber layer is worn down and faded white, or weft is worn down and invisible.	 Rotating direction SEM397A	● Poor belt cover sealing ● Engine coolant leakage at water pump ● Camshaft not functioning properly ● Distributor not functioning properly ● Excessive belt tension
Belt is contaminated by engine oil/engine coolant or water.	—	● Poor oil sealing of each oil seal ● Engine coolant leakage at water pump ● Poor belt cover sealing

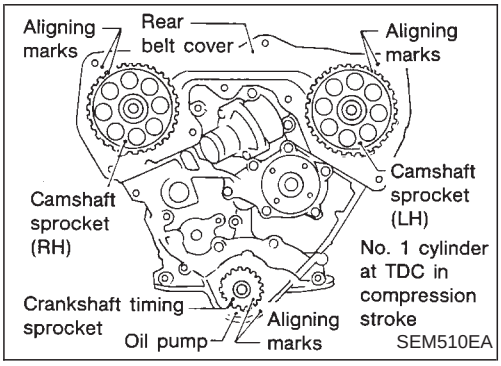
Inspection (Cont'd)

BELT TENSIONER AND TENSIONER SPRING


SEM558

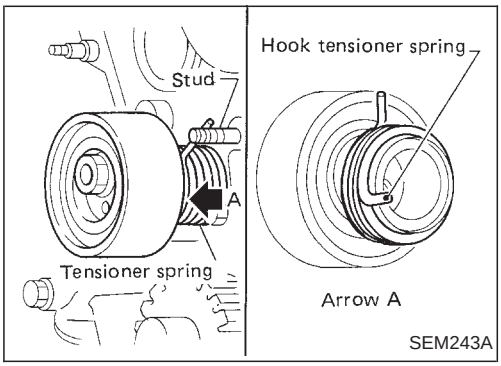
1. Check belt tensioner for smooth turning.
2. Check condition of tensioner spring.
3. Replace belt tensioner and tensioner spring as necessary.

Installation



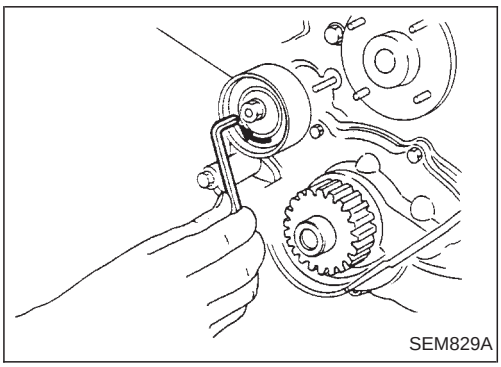
SEM510EA

1. Confirm that the No. 1 piston is set at TDC on the compression stroke.

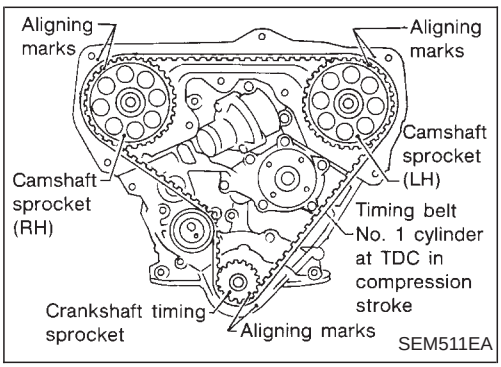


SEM243A

2. Install the tensioner and tensioner spring.
- Once the stud is removed, apply a locking sealant to the threads of the stud on cylinder block side before installing.


SEM829A

3. Turn the tensioner fully outward with a hexagon wrench, and temporarily tighten the lock nut.



SEM511EA

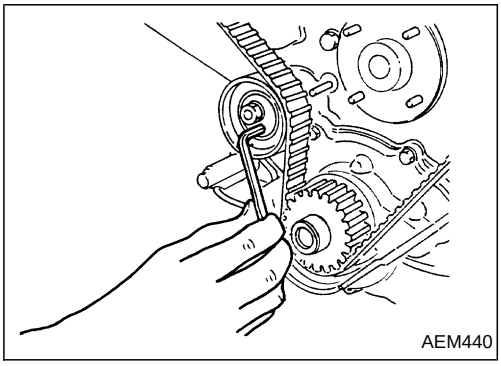
4. Set the timing belt when the engine is cold.
   1. Point the arrow on timing belt toward the front of the belt cover.
   2. Align the white lines on the timing belt with the punch-marks on the camshaft sprockets and crankshaft sprocket.

Installation (Cont'd)

Number of timing belt teeth for installation (reference):

Total number of timing belt teeth		133
Number of teeth between timing marks	Between LH and RH camshaft sprockets	40
	Between LH camshaft sprocket and crankshaft timing sprocket	43

5. Install the remaining parts in the reverse order of removal.

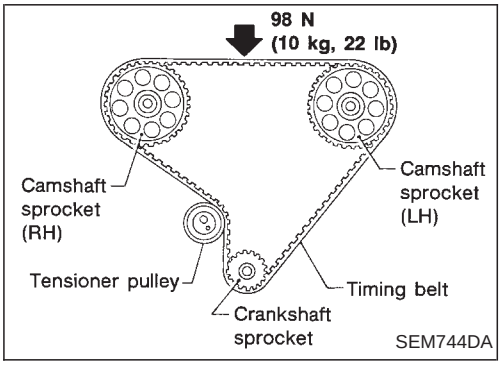

AEM440

Tension Adjustment

AFTER BELT REPLACEMENT

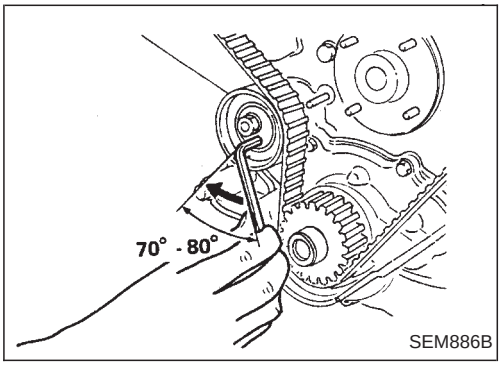
NOTE:
If the timing belt was replaced (or to adjust tension on a used belt), follow this procedure.

1. Loosen the tensioner lock nut, then turn tensioner clockwise and counterclockwise with a hexagon wrench at least two times.
2. Tighten the tensioner lock nut.
3. Turn the crankshaft clockwise a full rotation at least two times, then slowly set the No. 1 piston at TDC on the compression stroke.



SEM744DA

4. Measure the deflection of the timing belt midway between the camshaft sprockets while pushing with the specified force as shown.
   Belt deflection when engine is cold (reference value): 13 - 15 mm (0.51 - 0.59 in) at 98 N (10 kg, 22 lb) force
5. If the belt deflection is not within specification, return to step 1 and repeat the procedure.



SEM886B

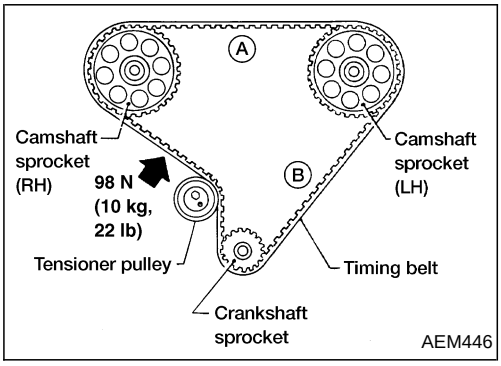
AFTER ENGINE OVERHAUL OR ENGINE REASSEMBLY (WITH ROCKER COVERS REMOVED)

NOTE:
If the engine was overhauled or previously disassembled (i.e. intake manifold or cylinder head were removed), follow this timing belt tension adjustment procedure.

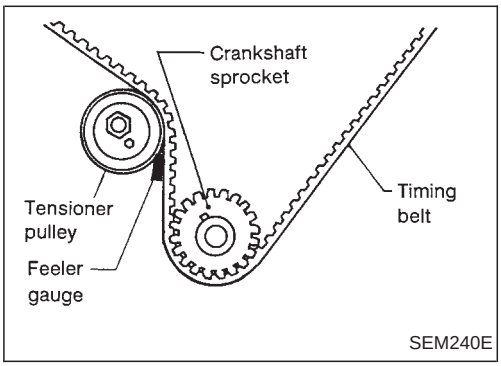
1. Loosen the rocker shaft bolts to relieve the belt tension caused by the camshafts.
2. Loosen the tensioner lock nut, keeping the tensioner steady with a hexagon wrench.

Tension Adjustment (Cont'd)

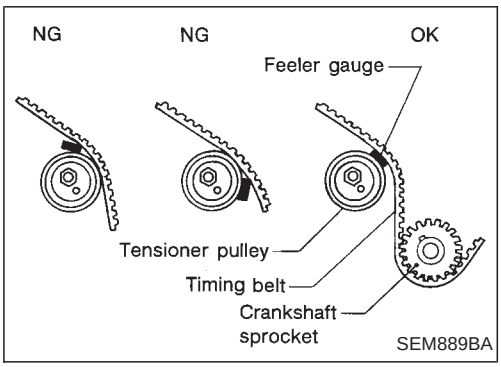
3. Turn the tensioner 70° to 80° degrees clockwise with a hexagon wrench to release the belt tension, and temporarily tighten the lock nut.
4 Turn the crankshaft clockwise at least twice, then slowly set the No. 1 piston at TDC on the compression stroke.



5. Push the middle of the timing belt between RH camshaft sprocket and tensioner pulley with the specified force [98 N (10 kg, 22 lb)] to apply tension on part "A" and part "B" of the timing belt as shown.
6. Loosen the tensioner lock nut, keeping the tensioner steady with a hexagon wrench.

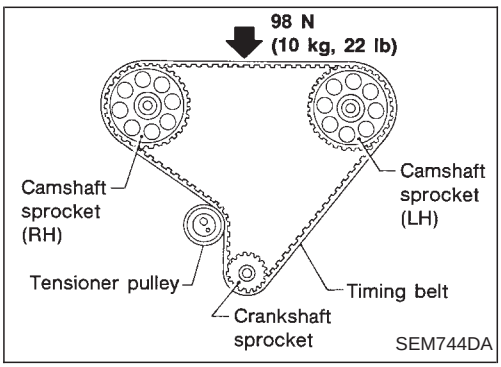


7. Position a feeler gauge size 0.5 mm (0.0206 in) thick and 12.7 mm (0.500 in) wide under the tensioner pulley as shown.



8. Turn the crankshaft clockwise until the feeler gauge is positioned between the tensioner pulley and the timing belt as shown.
- The timing belt will move about 2.5 teeth.

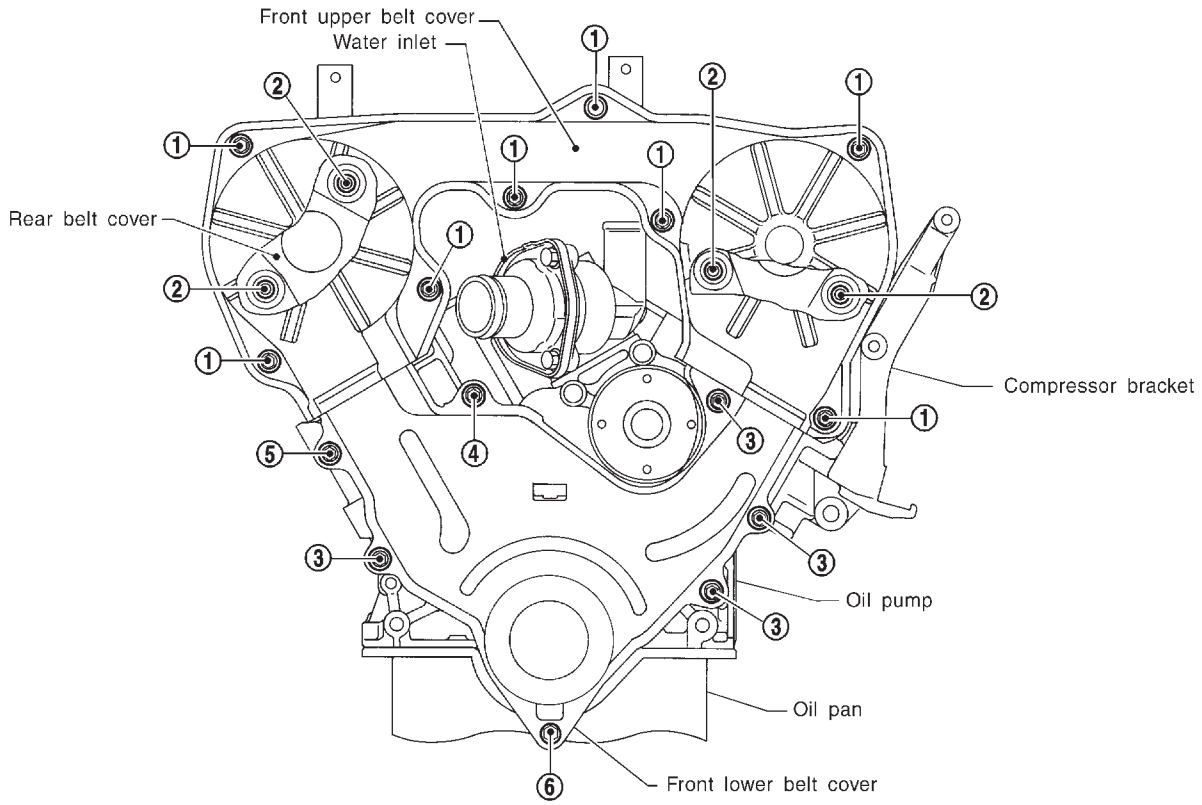
9. Tighten the tensioner lock nut, keeping the tensioner steady with a hexagon wrench.
10. Turn the crankshaft clockwise or counterclockwise to remove the feeler gauge.
11. Turn the crankshaft clockwise at least two full rotations, then slowly set the No. 1 piston at TDC on the compression stroke.



12. Measure the deflection of the timing belt midway between the camshaft sprockets while pushing with a force of 98 N (10 kg, 22 lb) as shown.
Belt deflection when engine is cold (Reference value):
13 - 15 mm (0.51 - 0.59 in) at 98 N (10 kg, 22 lb) force
13. If the belt deflection is not within specification, return to step 1 and repeat procedure.

Tension Adjustment (Cont'd)

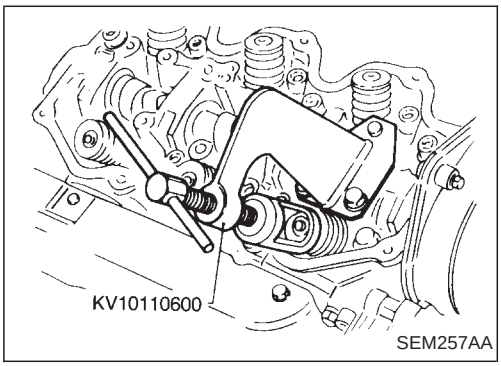
14. Install the lower and upper belt covers.



No.	Tightened parts		No.	Tightened parts	
①	Bolt, Rubber washer, Front upper belt cover, Welded nut	8 pcs.	④	Bolt, Rubber washer, Front lower belt cover	1 pc.
②	Hexagon bolt with washer, Rear belt cover	4 pcs.	⑤	Bolt, Rubber washer, Front lower belt cover	1 pc.
③	Bolt, Rubber washer, Front lower belt cover	4 pcs.	⑥	Bolt, Front lower belt cover, Lock spring washer	1 pc.

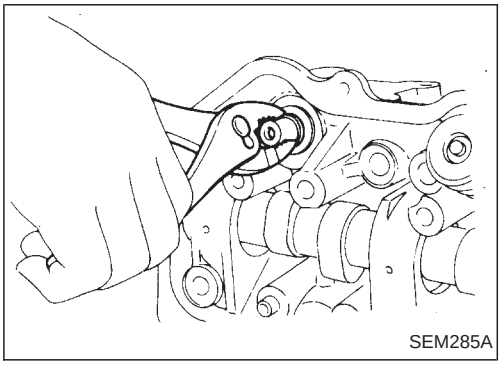
SEM313F

15. Install the remaining components in the reverse order of removal.

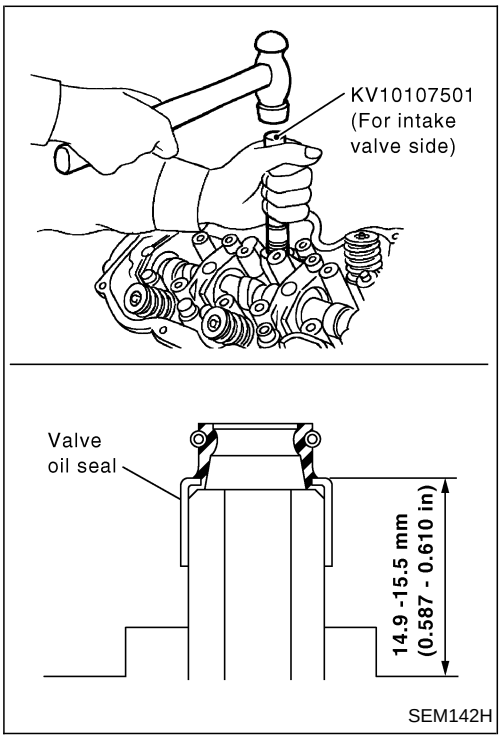


VALVE OIL SEAL

1. Remove rocker cover.
2. Remove rocker shaft assembly and valve lifters with valve lifter guide.
3. Remove valve springs using SST as shown.
- Piston concerned should be set at TDC to prevent valve from falling into the cylinder bore.



4. Remove valve oil seals.
- When removing intake side valve oil seal, use Tool or suitable tool.
- When removing exhaust side valve oil seal, pull it out with suitable tool.



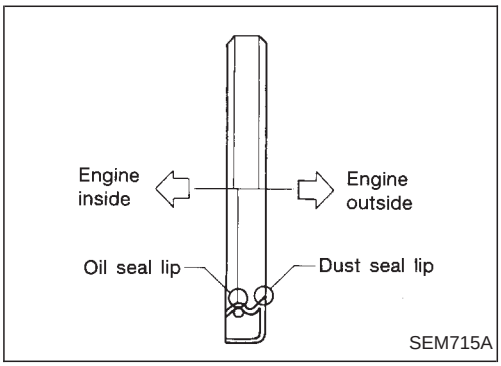
5. Apply engine oil to new valve oil seal and install it to specification as shown.
- When installing intake side valve oil seal, use SST as shown.
- When installing exhaust side valve oil seal, set it by hand.

CAMSHAFT OIL SEAL

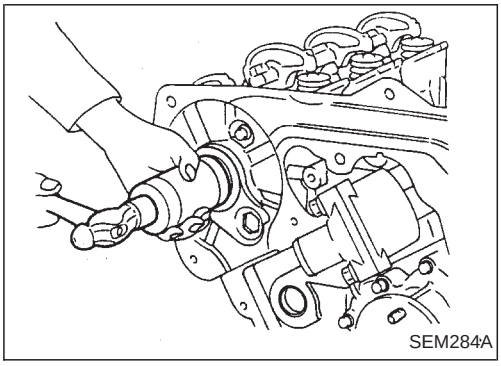
1. Remove timing belt. Refer to EM-19, “Removal”.
2. Remove camshaft sprocket. Refer to EM-18, “TIMING BELT”.
3. Remove camshaft. Refer to EM-28, “CYLINDER HEAD”.
4. Remove camshaft oil seal.

Be careful not to scratch cylinder head.

5. Apply engine oil to new camshaft oil seal.



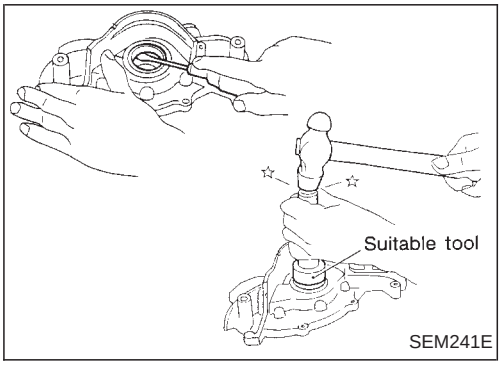
6. Position the oil seal in the specified direction as shown.



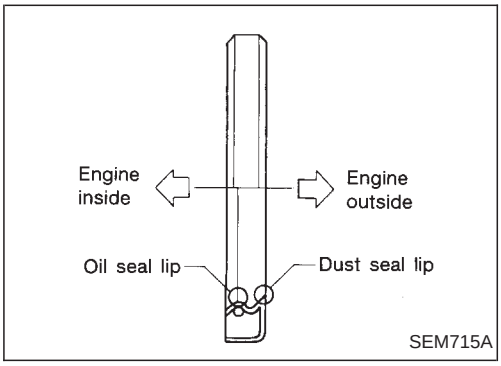
7. Install the oil seal using suitable drift.
8. Install the remaining parts in the reverse order of removal.

FRONT OIL SEAL

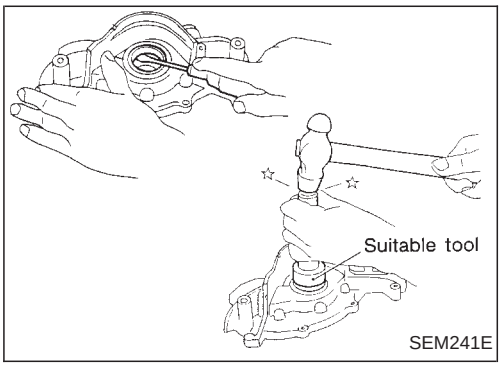
1. Remove timing belt and crankshaft sprocket. Refer to EM-19, “Removal”.
2. Remove oil pump assembly. Refer to “Oil Pump” in LC section.



3. Remove front oil seal from oil pump body.
4. Apply engine oil to new oil seal.



5. Position the oil seal with the correct orientation as shown.



6. Install the new oil seal using a suitable tool as shown.
7. Install the remaining parts in the reverse order of removal.

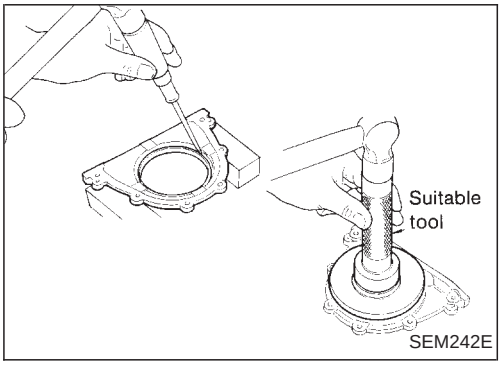
REAR OIL SEAL

1. Remove flywheel. Refer to CL section.
2. Remove rear oil seal retainer.
3. Remove rear oil seal from rear oil seal retainer.

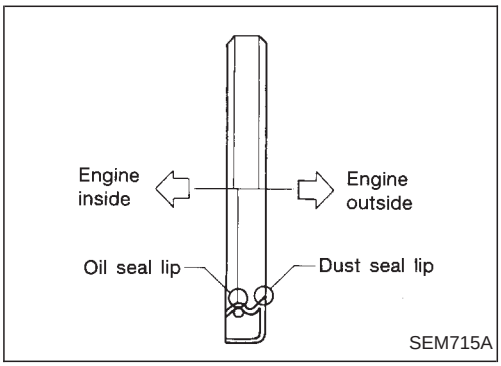
CAUTION:

Be careful not to scratch the rear oil seal retainer.

4. Apply engine oil to new oil seal.



5. Position the new oil seal as shown.

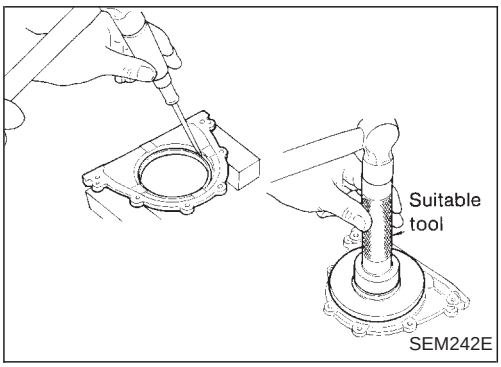


6. Install the new oil seal using a suitable tool.
7. Install rear oil seal retainer with a new gasket to cylinder block.

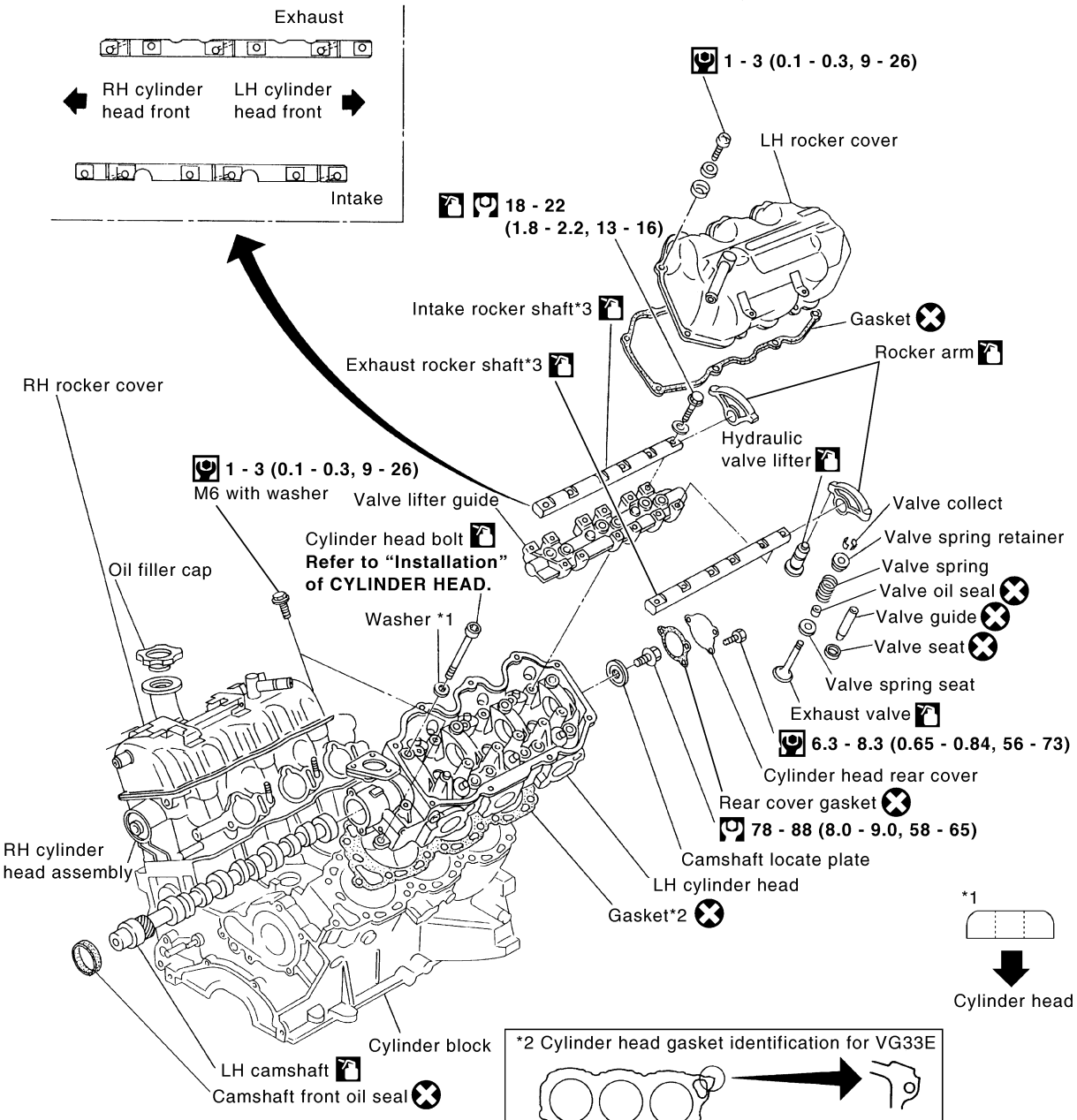
CAUTION:

Always use a new oil seal retainer gasket.

8. Install the remaining parts in the reverse order of removal.



SEC. 102•111•130



*3 : Be sure to align cut portion to cylinder head bolt.

: N•m (kg-m, in-lb)

: N•m (kg-m, ft-lb)

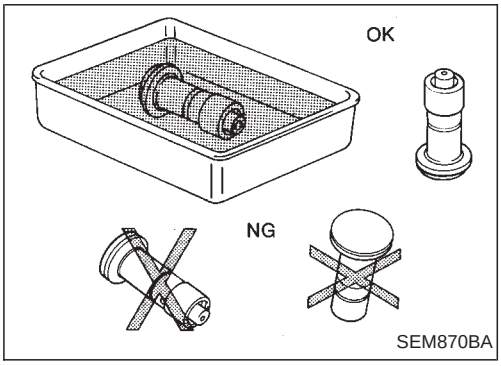
: Lubricate with new engine oil

: Always replace after every disassembly.

SEM139H

CAUTION:

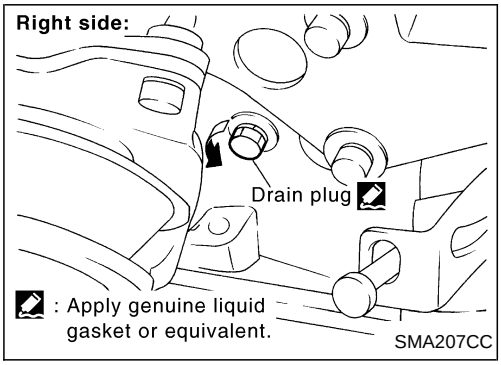
- **When installing sliding parts such as rocker arms, camshaft and oil seal, be sure to apply new engine oil on their sliding surfaces.**
- **When tightening cylinder head bolts and rocker shaft bolts, apply new engine oil to thread portions and seat surfaces of bolts.**



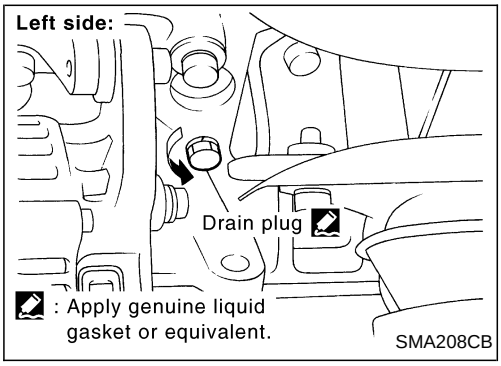
- **If hydraulic valve lifter is kept on its side, there is a risk of air entering it. After removal, always set hydraulic valve lifter straight up, or when laying it on its side, have it soak in new engine oil.**
- **Do not disassemble hydraulic valve lifter.**
- **Attach tags to valve lifters so as not to mix them up.**

Removal

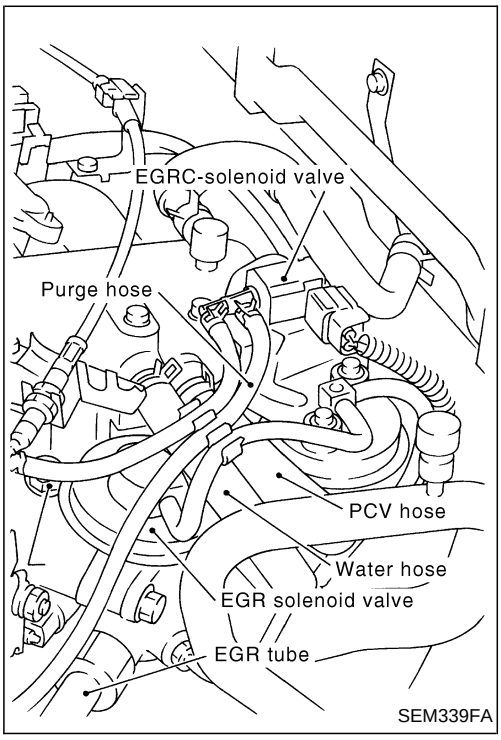
1. Release fuel pressure.
   Refer to “Releasing Fuel Pressure” in EC section.
2. Remove timing belt.
   Refer to EM-19, “Removal”.



3. Drain the engine coolant by removing drain plugs from both sides of cylinder block.

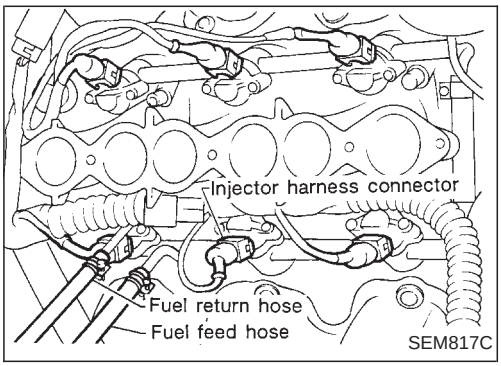


Removal (Cont'd)

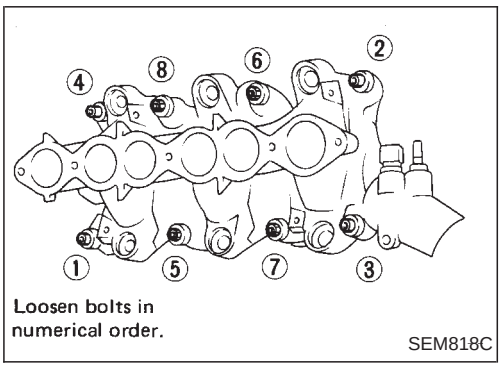


4. Separate accelerator control wire from intake manifold collector. Refer to FE section.
5. Remove intake manifold collector from engine. Refer to EM-9, "OUTER COMPONENT PARTS".
   The following parts should be disconnected to remove intake manifold collector.

a. Harness connectors for: IACV-AAC valve, Throttle position sensor, Throttle position switch, Distributor and EGRC-solenoid valve.
b. Water hoses from collector
c. Heater hoses
d. PCV hose from RH rocker cover
e. Vacuum hoses for: EVAP canister, Master brake cylinder and Pressure regulator
f. Purge hose from EVAP canister
g. EGR tube
h. Earth harnesses
i. Air duct hose

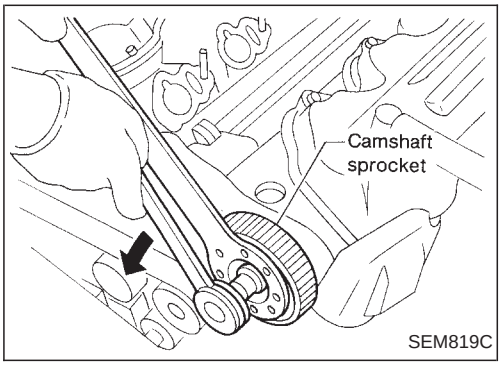


6. Remove fuel feed and fuel return hoses from injector fuel tube assembly.
7. Disconnect all injector harness connectors.
8. Remove injector fuel tube assembly. Refer to "Injector" in EC section.



9. Remove intake manifold from engine, loosen the bolts in numerical order as shown. Refer to EM-9, "OUTER COMPONENT PARTS".
   The following parts should be disconnected to remove intake manifold.

a. Engine coolant temperature switch harness connector
b. Thermal transmitter harness connector
c. Water hose from thermostat housing

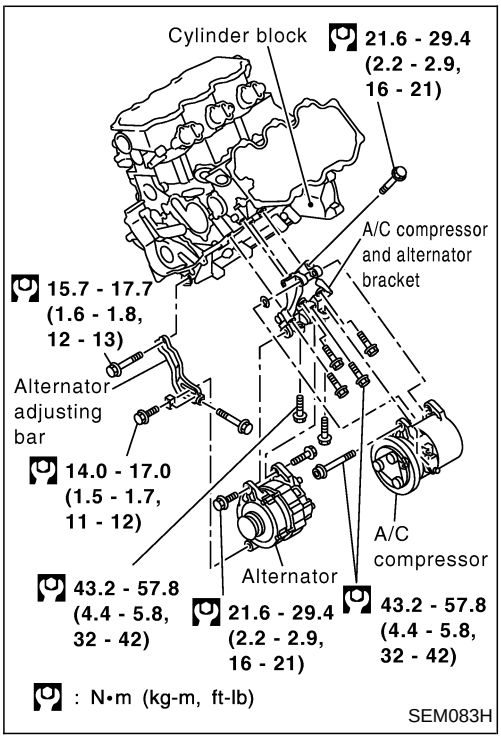


10. Remove both of the camshaft sprockets.
11. Remove rear timing belt cover.
12. Remove distributor and ignition wires.

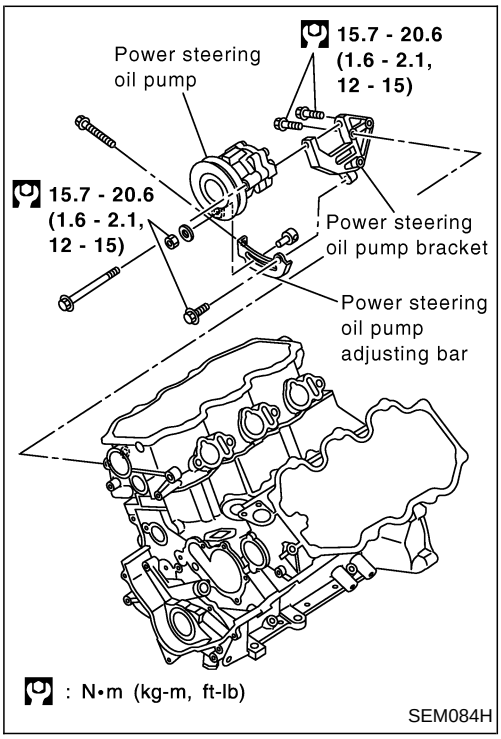
After removing distributor from cylinder head, do not rotate distributor rotor.

13. Remove harness clamp from RH rocker cover.
14. Remove front exhaust tube from exhaust manifold. Refer to "EXHAUST SYSTEM" in FE section.

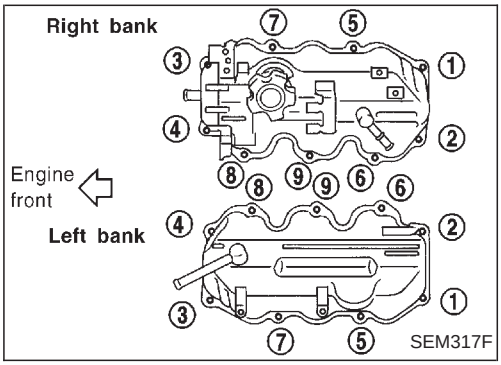
Removal (Cont'd)



15. Remove A/C compressor and alternator. Refer to HA and EL sections.
16. Remove A/C compressor and alternator bracket.

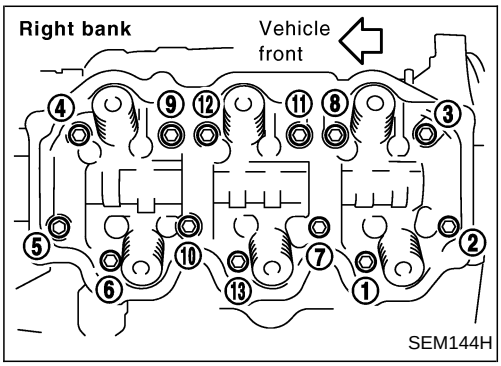


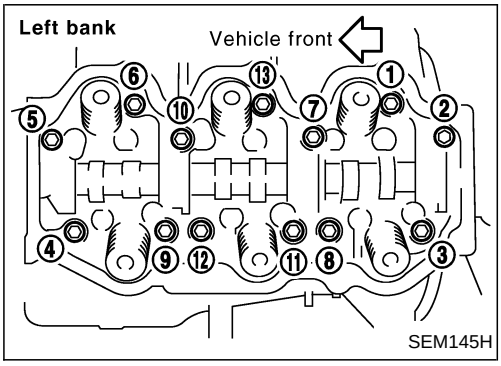
17. Remove power steering oil pump. Refer to ST section.
18. Remove power steering oil pump bracket.



19. Loosen and remove the bolts from both rocker covers in numerical order as shown. Remove both rocker covers.

Removal (Cont'd)

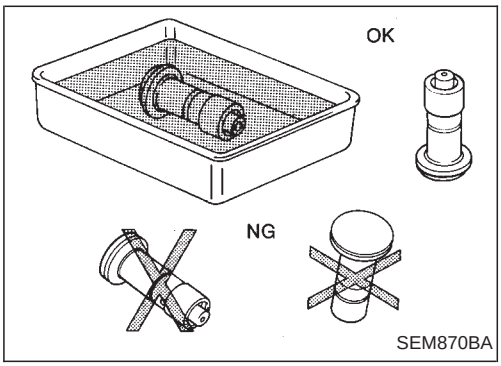




20. Remove cylinder head with exhaust manifold, loosen the bolts in the numerical order as shown.

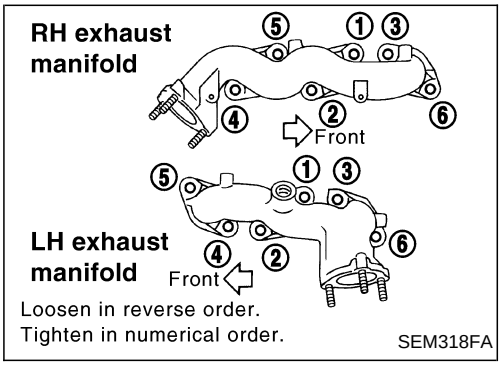
- **A warped or cracked cylinder head could result from not removing the cylinder head bolts in the specified numerical order.**
- **Cylinder head bolts should be loosened in two or three steps.**

Disassembly



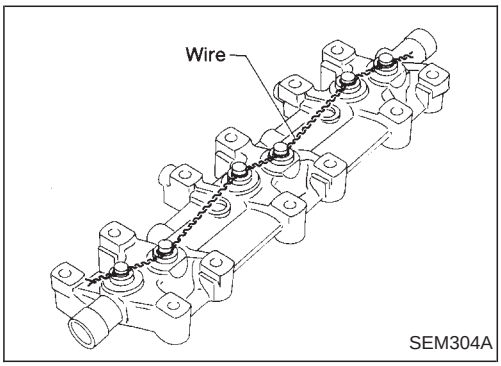
CAUTION:

- **When installing sliding parts such as rocker arms, camshaft and oil seal, be sure to apply new engine oil on their sliding surfaces.**
- **When tightening cylinder head bolts and rocker shaft bolts, apply new engine oil to thread portions and seat surfaces of bolts.**
- **If hydraulic valve lifter is kept on its side, there is a risk of air entering it. After removal, always set hydraulic valve lifter straight up, or when laying it on its side, have it soak in new engine oil.**
- **Do not disassemble hydraulic valve lifter.**
- **Attach tags to valve lifters so as not to mix them up.**

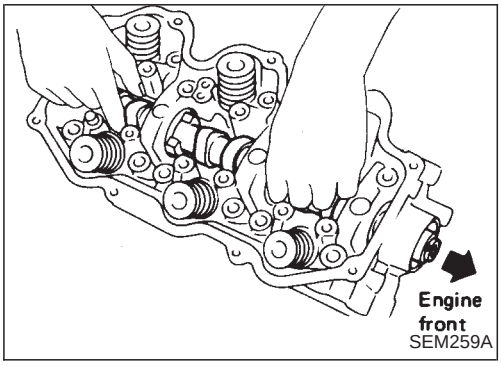


1. Remove exhaust manifolds from cylinder head.

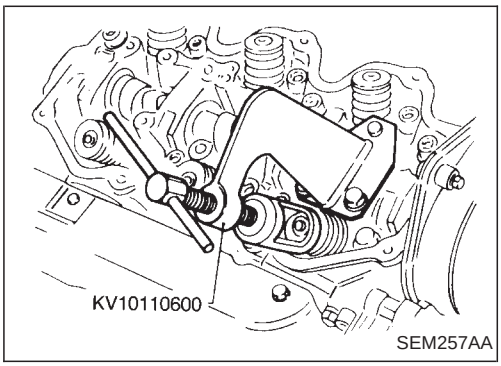
Disassembly (Cont'd)



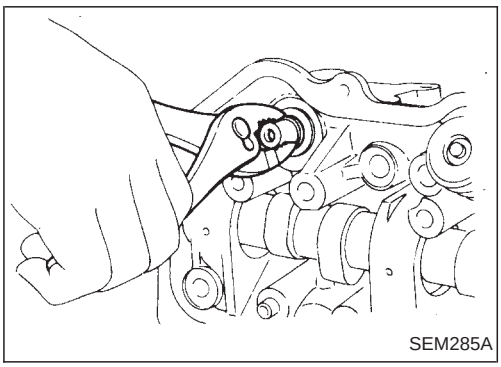
2. Remove rocker shafts with rocker arms.
- **Bolts should be loosened in two or three steps.**
3. Remove hydraulic valve lifters and lifter guide.
- **Hold hydraulic valve lifters with wire so that they will not drop from lifter guide.**



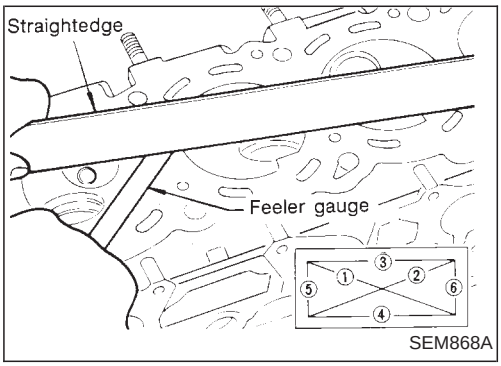
4. Remove oil seal and camshaft.
- **Before removing camshaft, measure camshaft end play. Refer to EM-35, "CAMSHAFT END PLAY".**



5. Remove valve components using SST as shown.



6. Remove valve oil seals using suitable tool.



Inspection

CYLINDER HEAD DISTORTION

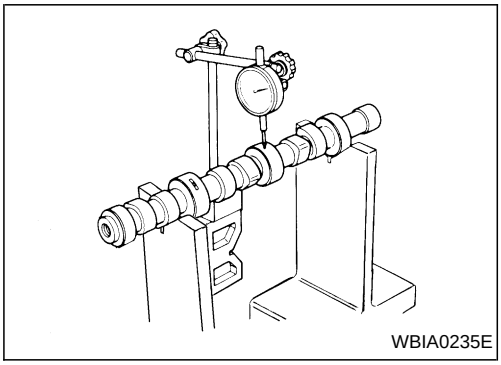
1. Measure the cylinder head surface using a straightedge and a feeler gauge as shown. If the surface flatness is beyond the specified limit, resurface it or replace it as necessary.
   Head surface flatness:
   Less than 0.1 mm (0.004 in)

Resurfacing limit:
The resurfacing limit of cylinder head is determined by the cylinder block resurfacing in an engine.
Amount of cylinder head resurfacing is "A".
Amount of cylinder block resurfacing is "B".
The maximum limit is as follows:
A + B = 0.2 mm (0.008 in)

2. After resurfacing cylinder head, check that camshaft rotates freely by hand. If resistance is felt, cylinder head must be replaced.
   Nominal cylinder head height:
   106.8 - 107.2 mm (4.205 - 4.220 in)

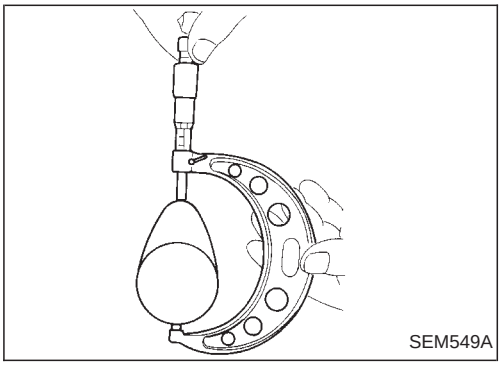
CAMSHAFT VISUAL CHECK

Check camshaft for scratches, seizure and wear. Replace as necessary.



CAMSHAFT RUNOUT

1. Support the camshaft at the No. 2 and No. 4 camshaft journals.
2. Measure camshaft runout at the No. 3 journal as shown.
   Runout (Total indicator reading):
   Limit 0.1 mm (0.004 in)
3. If it exceeds the limit, replace camshaft.

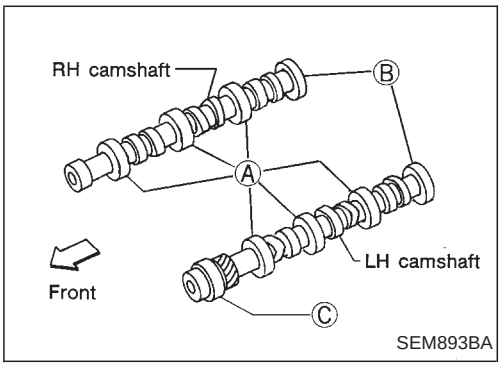


CAMSHAFT CAM HEIGHT

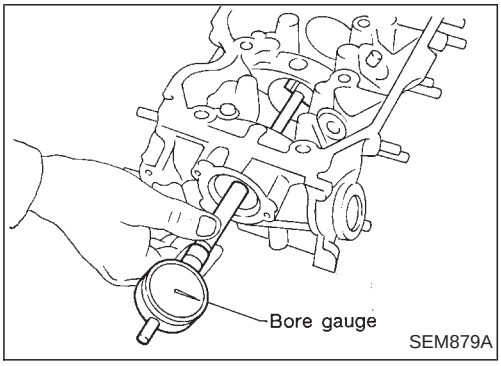
1. Measure camshaft cam height as shown.
   Standard cam height:
   Intake: 39.242 - 39.432 mm (1.5450 - 1.5524 in)
   Exhaust: 38.943 - 39.133 mm (1.5332 - 1.5407 in)
   Cam wear limit:
   0.15 mm (0.0059 in)
2. If wear is beyond the limit, replace camshaft.

Inspection (Cont'd)

CAMSHAFT JOURNAL CLEARANCE



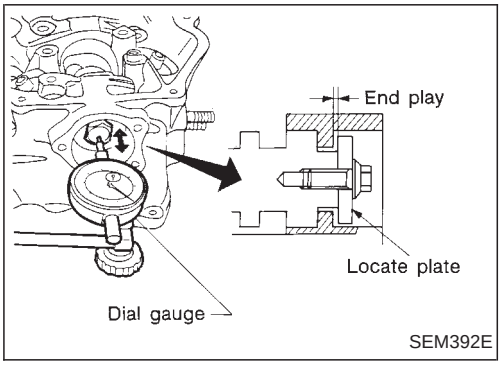
1. Measure outer diameter of camshaft journal.
   Standard outer diameter:
   A 46.920 - 46.940 mm (1.8472 - 1.8480 in)
   B 42.420 - 42.440 mm (1.6701 - 1.6709 in)
   C 47.920 - 47.940 mm (1.8866 - 1.8874 in)



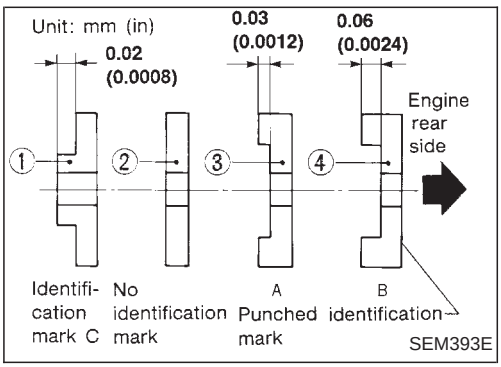
2. Measure inner diameter of camshaft bearing for the corresponding camshaft journal positions measured in step 1.
   Standard inner diameter:
   A 47.000 - 47.025 mm (1.8504 - 1.8514 in)
   B 42.500 - 42.525 mm (1.6732 - 1.6742 in)
   C 48.000 - 48.025 mm (1.8898 - 1.8907 in)

3. If clearance exceeds the limit, replace camshaft and/or cylinder head.
   Camshaft journal clearance limit:
   0.15 mm (0.0059 in)

CAMSHAFT END PLAY

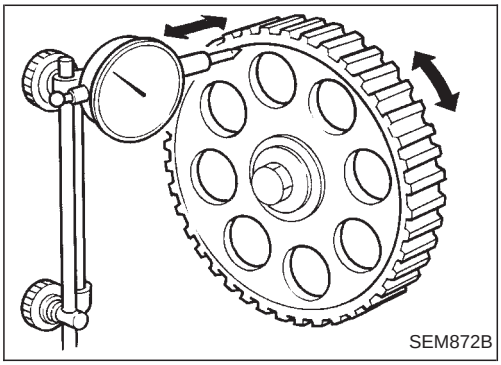


1. Install camshaft and locate plate in cylinder head.
2. Measure camshaft end play.
   Camshaft end play:
   Standard 0.03 - 0.06 mm (0.0012 - 0.0024 in)



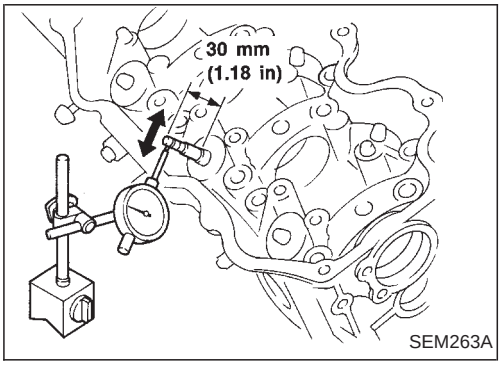
3. If it is out of the specified range, select thickness of camshaft locate plate to obtain standard specified end play.
   Example:
   When camshaft end play is 0.08 mm (0.0031 in) with camshaft locate plate ② , replace camshaft locate plate ② with camshaft locate plate ③ to set the end play at 0.05 mm (0.0020 in).

Inspection (Cont'd)


SEM872B

CAMSHAFT SPROCKET RUNOUT

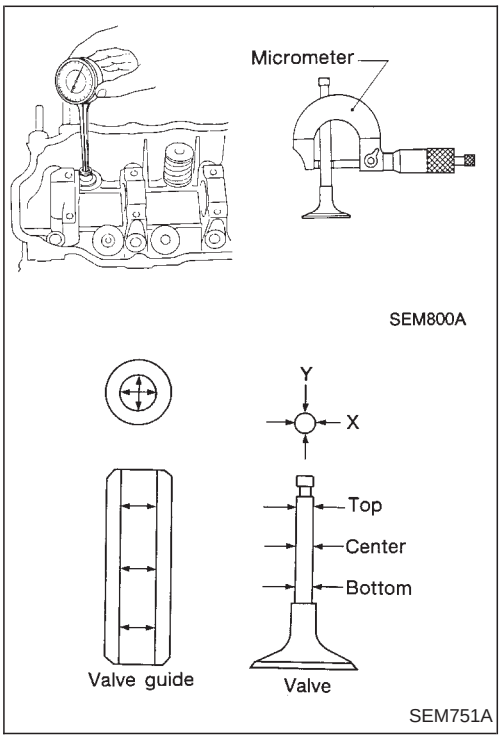
1. Support the camshaft at the No. 2 and No.4 camshaft journals.
2. Install sprocket on camshaft.
3. Measure camshaft sprocket runout.
   Runout (Total indicator reading):
   Limit 0.1 mm (0.004 in)
4. If it exceeds the limit, replace camshaft sprocket.



SEM263A

VALVE GUIDE CLEARANCE

1. Measure valve deflection in a right-angled direction with camshaft. Valve and valve guide mostly wear in this direction.
   Valve deflection limit (Dial gauge reading):
   0.20 mm (0.0079 in)



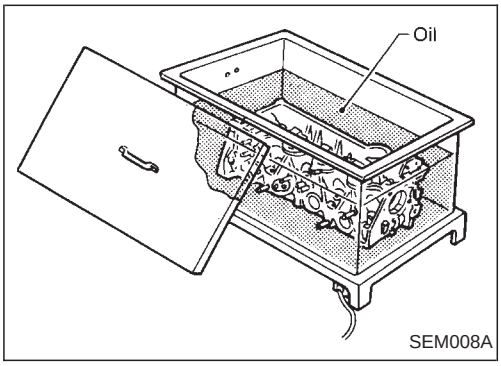
SEM751A

2. If it exceeds the limit, check valve to valve guide clearance.

a. Measure valve stem diameter and valve guide inner diameter.

b. Check that clearance is within specification.
   Valve to valve guide clearance:
   Intake
   0.020 - 0.053 mm (0.0008 - 0.0021 in)
   Exhaust
   0.030 - 0.049 mm (0.0012 - 0.0019 in)
   Limit
   0.10 mm (0.0039 in)

c. If it exceeds the limit, replace valve or valve guide.

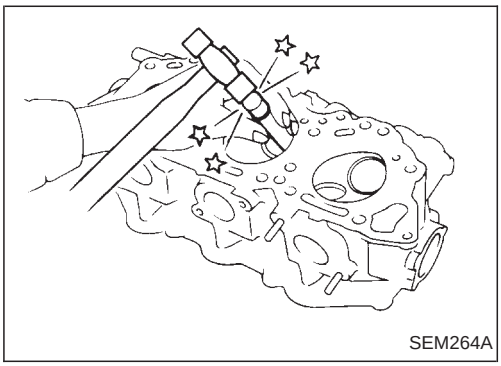


SEM008A

VALVE GUIDE REPLACEMENT

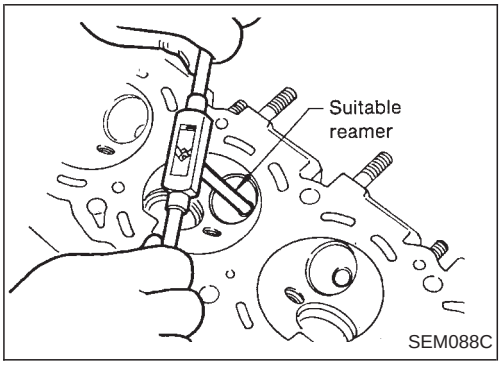
1. To remove valve guide, heat cylinder head to 150 to 160°C (302 to 320°F) by soaking in heated oil.

Inspection (Cont'd)


SEM264A

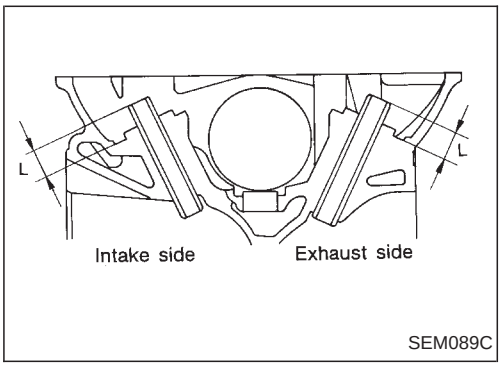
2. Drive out valve guide with a press [under a 20 kN (2 ton, 2.2 US ton, 2.0 Imp ton) pressure] or hammer and suitable tool.

WARNING:
Cylinder head contains heat. When working, wear protective equipment to avoid getting burned.



SEM088C

3. Ream cylinder head valve guide hole to specification for the service valve guide part as shown.
   Valve guide hole diameter
   (for service parts):
   Intake
   11.175 - 11.196 mm (0.4400 - 0.4408 in)
   Exhaust
   12.175 - 12.196 mm (0.4793 - 0.4802 in)



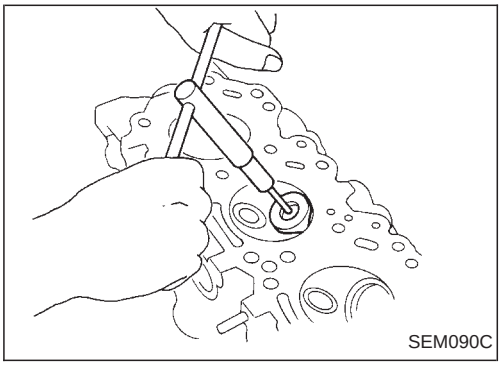
SEM089C

4. Heat cylinder head to 150 to 160°C (302 to 320°F) and press service valve guide onto cylinder head to the specified height as shown.

WARNING:
Cylinder head contains heat. When working, wear protective equipment to avoid getting burned.

   Height "L":
   13.2 - 13.4 mm (0.520 - 0.528 in)

5. Ream out the new service valve guide in the cylinder head to the specified diameter.
   Valve guide finished inner diameter:
   Intake
   7.000 - 7.018 mm (0.2756 - 0.2763 in)
   Exhaust
   8.000 - 8.018 mm (0.3150 - 0.3157 in)

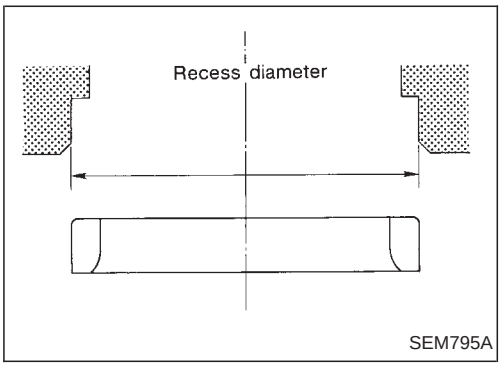

SEM090C

VALVE SEATS

Check valve seats for any evidence of pitting at valve contact surface, and re-surface or replace the valve seat if it has worn out.

- **Before repairing valve seats, check valve and valve guide for wear. If they have worn, replace them. Then correct valve seat. Refer to EM-64, "VALVE".**
- **Use both hands to cut uniformly.**

Inspection (Cont'd)



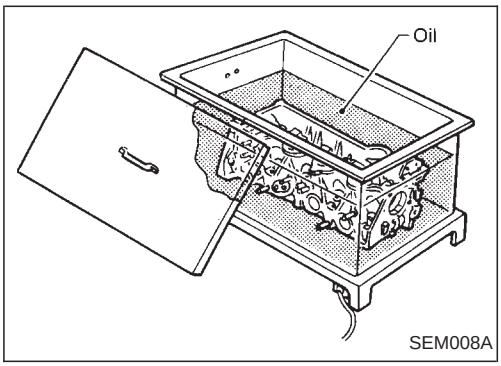
REPLACING VALVE SEAT FOR SERVICE PARTS

1. Bore out old seat until it collapses. The machine depth stop should be set so that boring cannot continue beyond the bottom face of the seat recess in cylinder head.
2. Ream cylinder head recess.

CAUTION:

Reaming should be done in circles concentric to the valve guide center so that valve seat will have the correct fit.

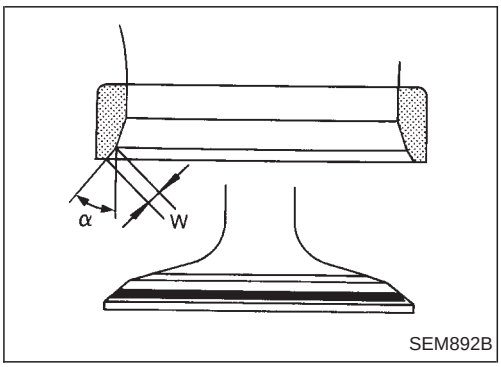
Reaming bore for service valve seat
Oversize [0.5 mm (0.020 in)]:
Intake
44.500 - 44.516 mm (1.7520 - 1.7526 in)
Exhaust
37.500 - 37.516 mm (1.4764 - 1.4770 in)



3. Heat cylinder head to 150 to 160°C (302 to 320°F) by soaking in heated oil.
4. Press fit valve seat until it seats on the bottom of the valve seat bore.

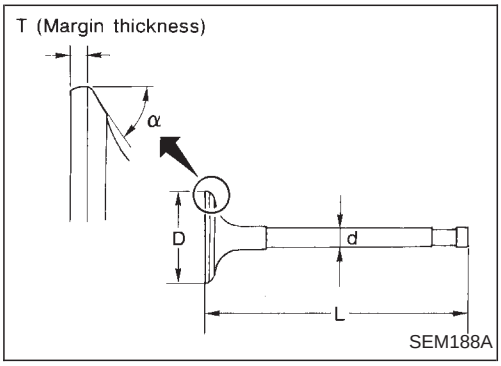
WARNING:

Cylinder head contains heat. When working, wear protective equipment to avoid getting burned.



5. Cut or grind valve seat using suitable tool at the specified dimensions as shown in SDS. Refer to EM-64, "VALVE".
6. After cutting, lap valve seat with abrasive compound.
7. Check valve seating condition.

		Intake	Exhaust
Seat face angle "α"	degree	45	45
Contacting width "W"	mm (in)	1.75 (0.0689)	1.7 (0.067)



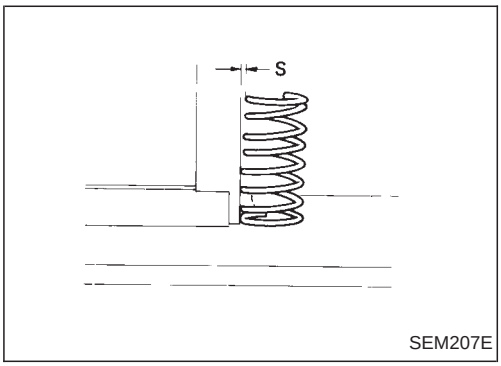
VALVE DIMENSIONS

Check dimensions in each valve. Refer to EM-64, "VALVE".
When valve head has been worn down to 0.5 mm (0.020 in) in margin thickness, replace valve.

Grinding allowance for valve stem tip is 0.2 mm (0.008 in) or less.

Inspection (Cont'd)

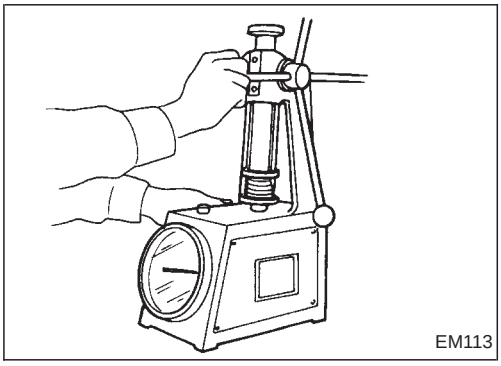
VALVE SPRING



SEM207E

Squareness

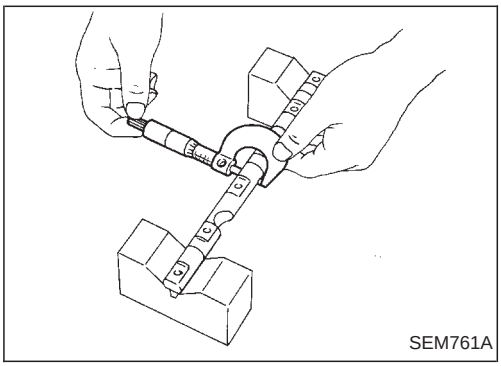
1. Measure "S" dimension of the valve spring against a right angle tool for out-of-square as shown.
   Out-of-square:
   Less than 2.0 mm (0.079 in)
2. If it exceeds the limit, replace spring.


EM113

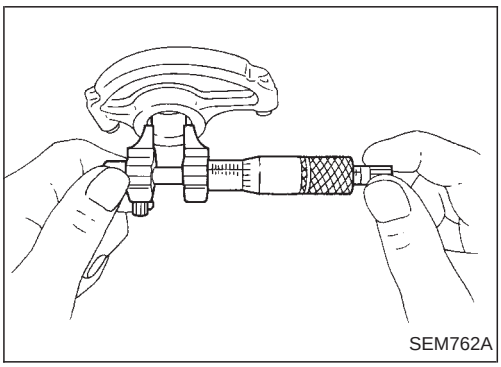
Pressure

1. Check valve spring pressure.
   Pressure:
   Installation
   349 - 380 N (35.6 - 38.8 kg, 78.5 - 85.4 lb) at height 40.0 mm (1.575 in)
   Valve open
   770 - 837 N (78.5 - 85.4 kg, 173.1 - 188.2 lb) at height 30.0 mm (1.181 in)
2. If not within specification, replace the valve spring.

ROCKER SHAFT AND ROCKER ARM


SEM761A

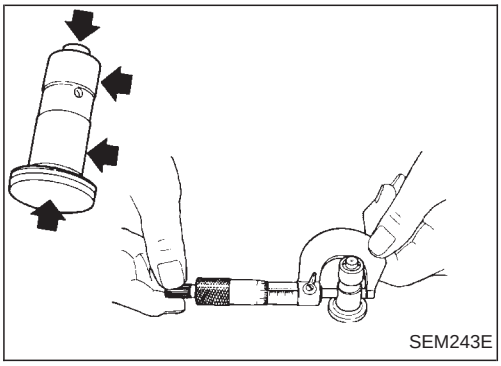
1. Check rocker shafts for scratches, damage and wear.
2. Check outer diameter of rocker shaft.
   Diameter:
   17.979 - 18.000 mm (0.7078 - 0.7087 in)


SEM762A

3. Check inner diameter of rocker arm.
   Diameter:
   18.007 - 18.028 mm (0.7089 - 0.7098 in)
4. Calculate rocker arm to shaft clearance by outer diameter of rocker shaft and inner diameter of rocker arm.
   Rocker arm to shaft clearance:
   0.007 - 0.040 mm (0.0003 - 0.0016 in)

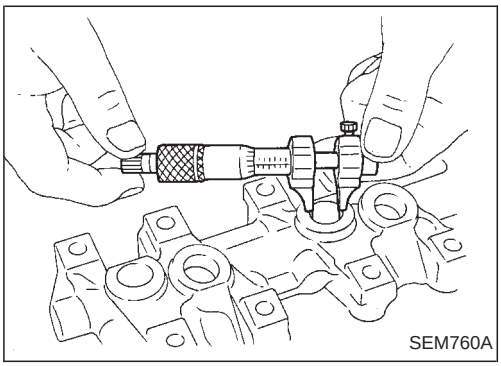
CAUTION:
Keep rocker arm with hydraulic valve lifter standing to prevent air from entering hydraulic valve lifter when checking.

HYDRAULIC VALVE LIFTER


SEM243E

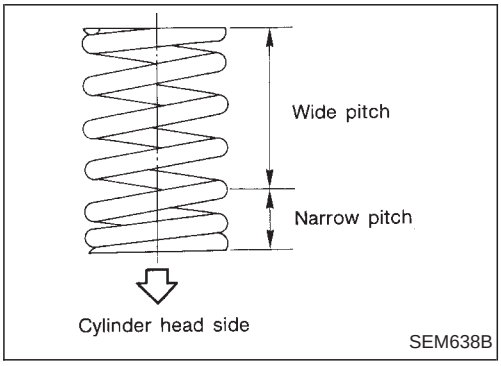
1. Check contact and sliding surfaces for wear or scratches.
2. Check the outer diameter of valve lifter.
   Outer diameter:
   15.947 - 15.957 mm (0.6278 - 0.6282 in)

Inspection (Cont'd)


SEM760A

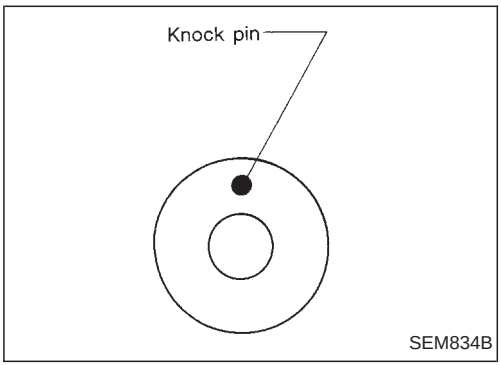
3. Check valve lifter guide inner diameter.
   Valve lifter guide inner diameter:
   16.000 - 16.013 mm (0.6299 - 0.6304 in)
4. Calculate clearance between valve lifter and valve lifter guide by outer diameter of valve lifter and valve lifter guide inner diameter.
   Standard clearance between valve lifter and valve lifter guide:
   0.043 - 0.066 mm (0.0017 - 0.0026 in)

Assembly



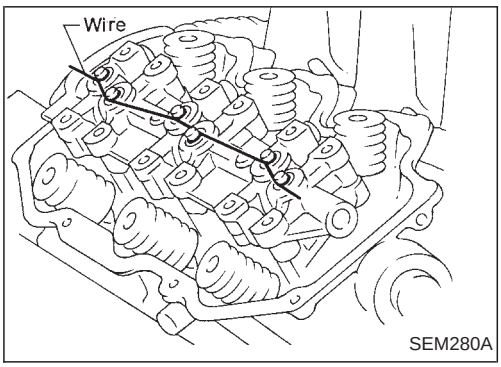
SEM638B

1. Install valve component parts.
- **Always use new valve oil seal. Refer to EM-25, "OIL SEAL REPLACEMENT".**
- **Install valve spring (uneven pitch type) with its narrow pitch side toward cylinder head side.**
- **After installing valve component parts, use plastic hammer to lightly tap valve stem tip to assure a proper fit.**



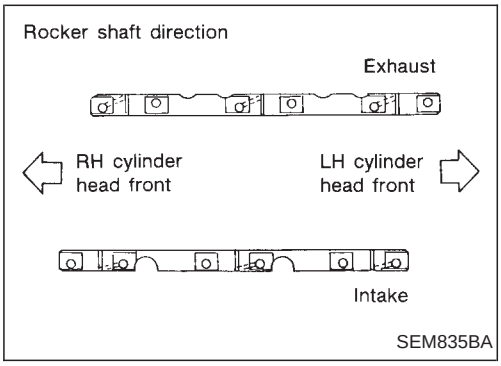
SEM834B

2. Install camshafts, locate plates and cylinder head rear covers.
- **Position the knock pin of camshaft at the top as shown.**



SEM280A

3. Install valve lifters and valve lifter guide.
- **Assemble valve lifters to their original position and hold all valve lifters with wire to prevent lifters from falling out of the guide.**
- **After installing, remove the wire.**

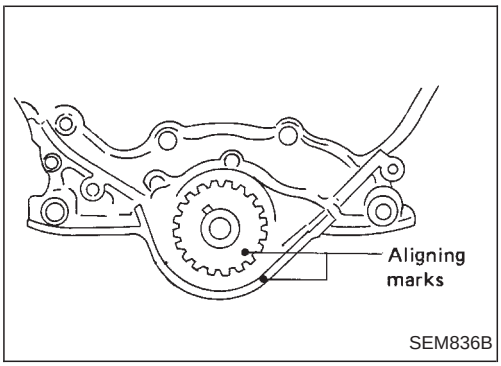


SEM835BA

4. Install rocker shafts with rocker arms.
- **Tighten bolts gradually in two or three stages to specification in the following camshaft positions.**
- **Before tightening, be sure to set camshaft the lobe at the position where lobe is not lifted.**

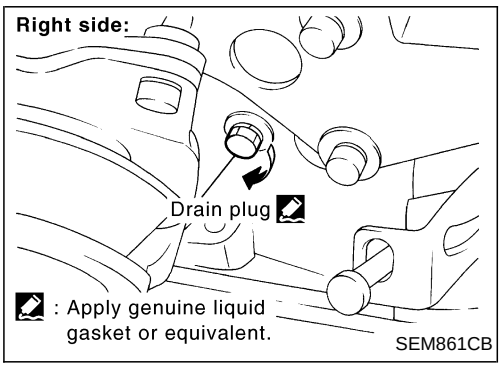
a. Set No. 1 piston at TDC on its compression stroke and tighten rocker shaft bolts for No. 2, No. 4 and No. 6 cylinders.
b. Set No. 4 piston at TDC on its compression stroke and tighten rocker shaft bolts for No. 1, No. 3 and No. 5 cylinders.

5. Install exhaust manifold to cylinder head in reverse order of removal.



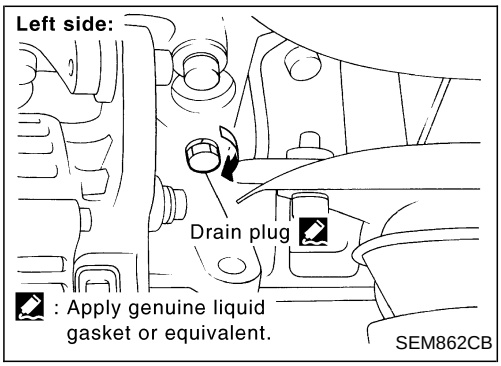
Installation

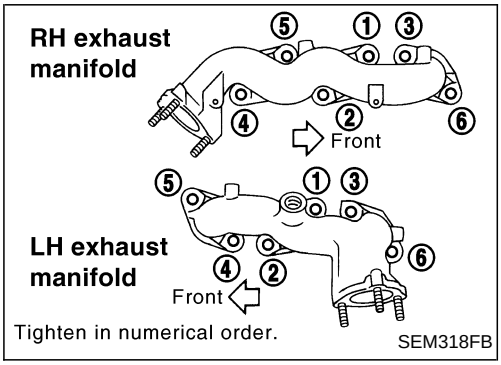
1. Set No. 1 piston at TDC on its compression stroke as follows:
a. Align crankshaft sprocket aligning mark with mark on oil pump body.
b. Confirm that knock pin on camshaft is set at the top.



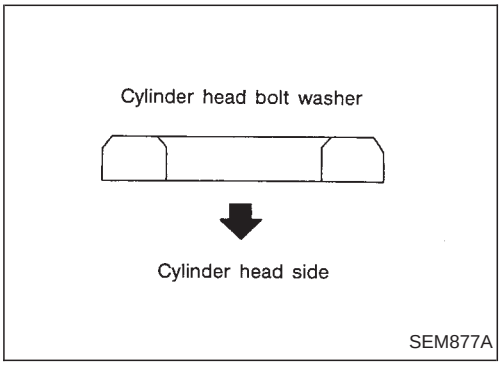
2. Install both drain plugs.
- Apply sealant to drain plug threads. Apply genuine liquid gasket or equivalent.

Drain plug:
34 - 44 N·m (3.5 - 4.4 kg-m, 25 - 32 ft-lb)



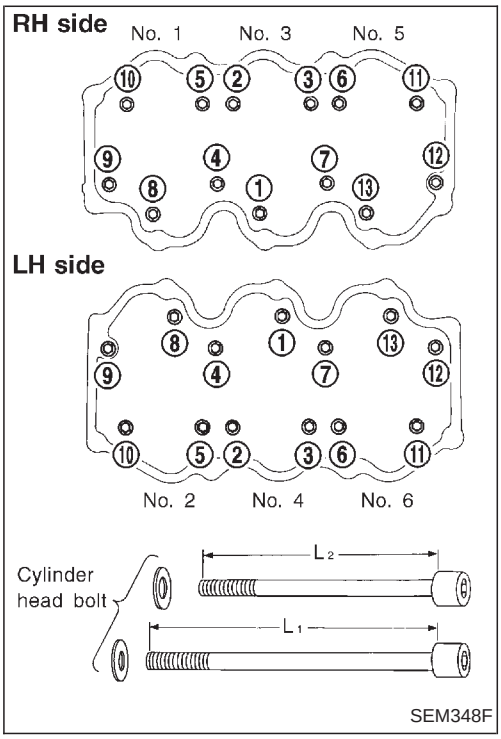


3. Install exhaust manifolds to cylinder head.
Refer to EM-9, “OUTER COMPONENT PARTS” for tightening torque.



4. Install cylinder head with new gasket.
- **Be sure to install washers between bolts and cylinder head with the beveled side up, as shown.**
- **Do not rotate crankshaft and camshaft separately, or valves will hit piston heads.**

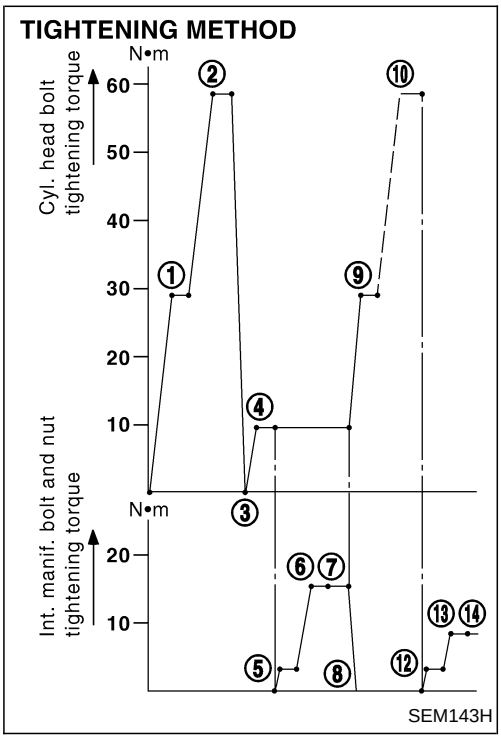
Installation (Cont'd)



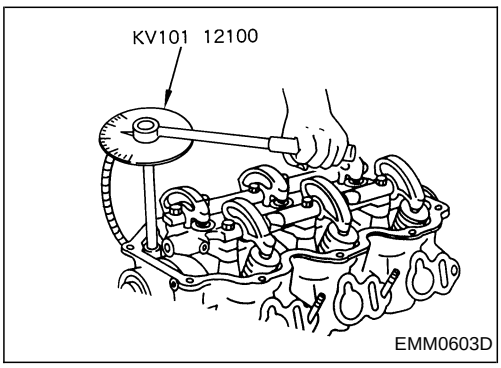
5. Tighten cylinder head bolts in numerical order as shown using angle wrench [ST10120000 (J24239-01)].

Apply engine oil to threads and seating surfaces of cylinder head bolts before installing them.

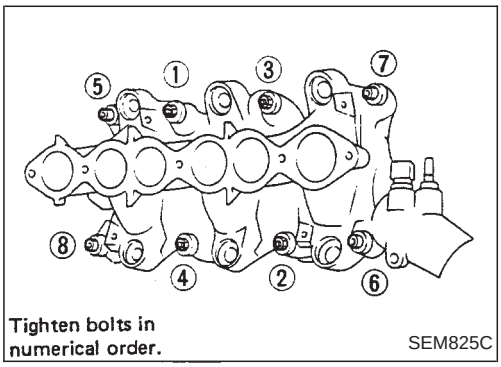
- **Cylinder head bolts for ④, ⑦, ⑨ and ⑫ are longer than the others.**
  L_1: 127 mm (5.00 in) for ④, ⑦, ⑨ and ⑫
  L_2: 106 mm (4.17 in) for others
- **Install intake manifold and cylinder head at the same time using the following procedure:**



(1) Tighten cylinder head bolts to 29 N·m (3.0 kg-m, 22 ft-lb).
(2) Tighten cylinder head bolts to 59 N·m (6.0 kg-m, 43 ft-lb).
(3) Loosen cylinder head bolts completely.
(4) Tighten cylinder head bolts to 10 N·m (1.0 kg-m, 7 ft-lb).
(5) Tighten intake manifold bolts and nuts to 4 N·m (0.4 kg-m, 35 in-lb).
(6) Tighten intake manifold bolts and nuts to 18 N·m (1.8 kg-m, 13 ft-lb).
(7) Tighten intake manifold bolts and nuts to 16 to 20 N·m (1.6 to 2.0 kg-m, 12 to 14 ft-lb).
(8) Loosen intake manifold bolts and nuts completely.
(9) Tighten cylinder head to 29 N·m (3.0 kg-m, 22 ft-lb).
(10) Turn cylinder head bolts to 60 to 65 degrees clockwise. If an angle wrench is not available, tighten cylinder head bolts to 54 to 64 N·m (5.5 to 6.5 kg-m, 40 to 47 ft-lb).
(11) Tighten cylinder head sub-bolts to 9.0 to 11.8 N·m (0.92 to 1.20 kg-m, 80 to 104 in-lb).
(12) Tighten intake manifold bolts and nuts to 4 N·m (0.4 kg-m, 35 in-lb).
(13) Tighten intake manifold bolts and nuts to 9 N·m (0.9 kg-m, 80 in-lb).
(14) Tighten intake manifold bolts and nuts to 8 to 10 N·m (0.8 to 1.0 kg-m, 71 to 88 in-lb).



Installation (Cont'd)

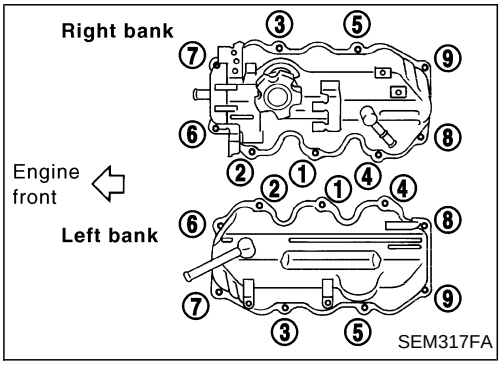


If only intake manifold is removed and to be used again, install it using the following procedure:

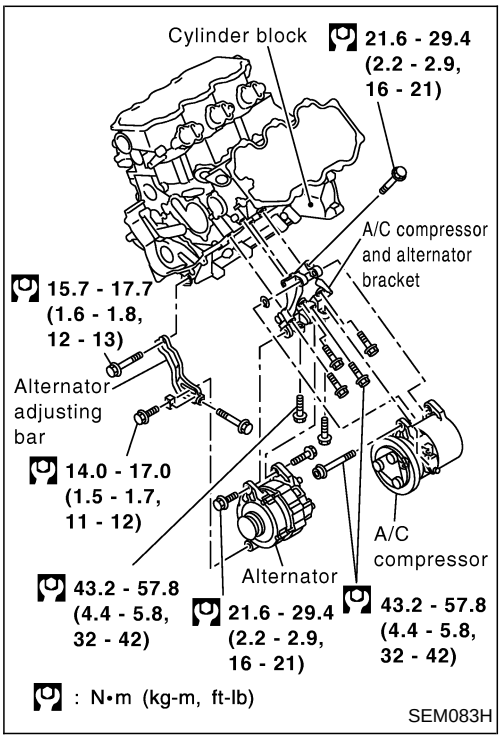
(1) Tighten all bolts and nuts to 4 N·m (0.4 kg-m, 35 in-lb).
(2) Tighten all bolts and nuts to 9 N·m (0.9 kg-m, 80 in-lb).
(3) Tighten all bolts and nuts to 8 to 10 N·m (0.8 to 1.0 kg-m, 71 to 88 in-lb).

CAUTION:

If replacing intake manifold with a new one, cylinder head gasket must also be replaced. Refer to step 4.

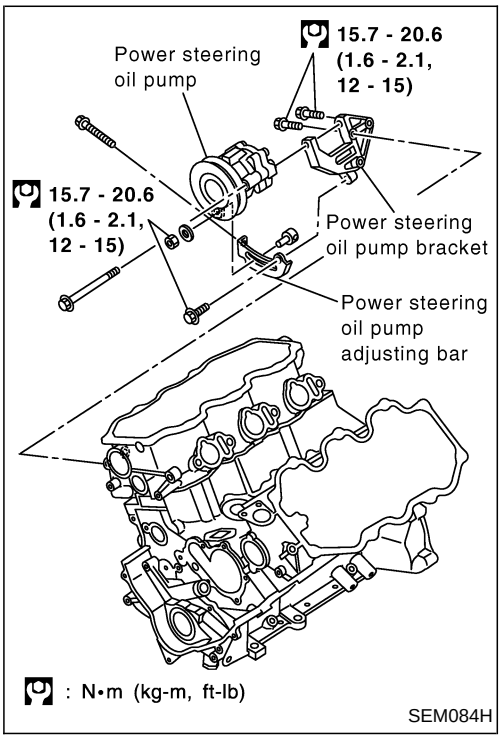


6. Install both rocker covers in numerical order as shown.
   Rocker cover bolt:
   : 1 - 3 N·m (0.1 - 0.3 kg-m, 9 - 26 in-lb)

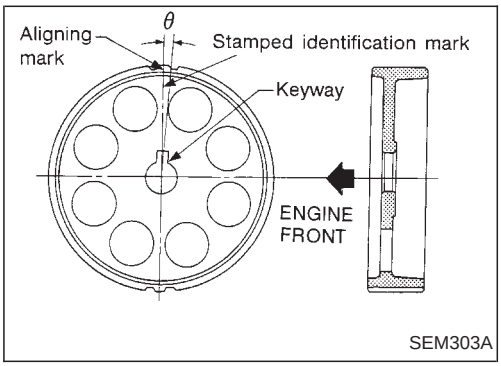


7. Install A/C compressor and alternator bracket.
8. Install alternator and A/C compressor. Refer to EL and HA sections.

Installation (Cont'd)



9. Install power steering oil pump bracket and power steering oil pump. Refer to ST section.
10. Install exhaust front tube to exhaust manifold. Refer to "EXHAUST SYSTEM" in FE section.

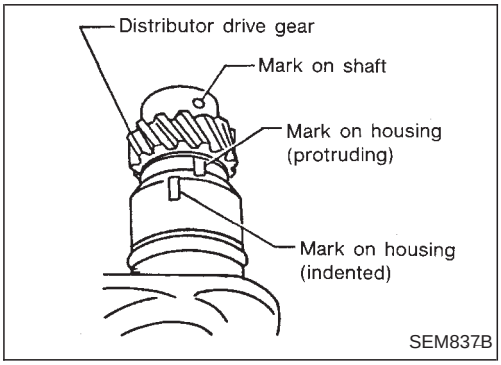


11. Install rear belt cover and camshaft sprocket. Refer to EM-18, "TIMING BELT".

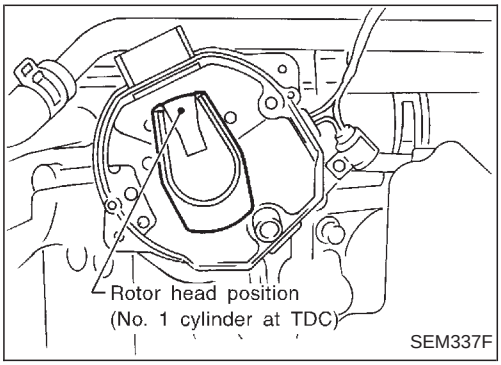
- **RH camshaft sprocket and LH camshaft sprocket are different parts. Be sure to install them in the correct location.**

	Identification mark	θ
RH camshaft sprocket	R3	0°53′
LH camshaft sprocket	L3	−3°27′

12. Install timing belt and adjust belt tension. Refer to EM-21, "Installation".

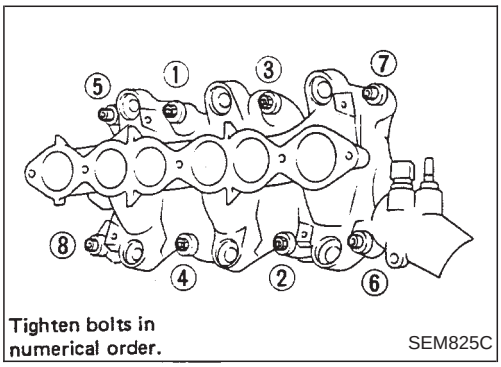


13. Install distributor.
(1) Align mark on shaft with protruding mark on housing.



(2) After installing, confirm that distributor rotor head is set as shown in figure.

Installation (Cont'd)



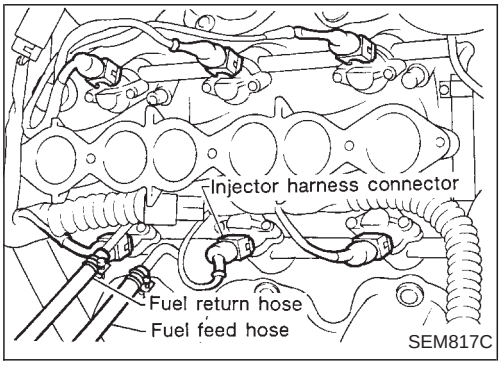
Tighten bolts in numerical order. SEM825C

14. Install intake manifold.
    Install all parts which were removed in step 9 under "CYLINDER HEAD — Removal".
- **If only intake manifold is removed and to be used again, install it using the following procedure:**

(1) Tighten all bolts and nuts to 4 N·m (0.4 kg-m, 35 in-lb).
(2) Tighten all bolts and nuts to 9 N·m (0.9 kg-m, 80 in-lb).
(3) Tighten all bolts and nuts to 8 to 10 N·m (0.8 to 1.0 kg-m, 71 to 88 in-lb).

CAUTION:
If replacing intake manifold with a new one, cylinder head gasket must also be replaced with a new one. Refer to Step 4.

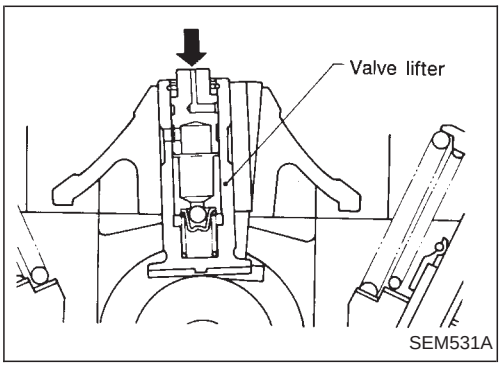
15. Install injector fuel tube assembly. Refer to "Injector" in EC section.
16. Connect all injector harness connectors.
17. Install fuel feed and fuel return hoses to injector fuel tube assembly.
18. Install intake manifold collector.
    Install all parts which were removed in step 5 under "CYLINDER HEAD — Removal".
19. Install accelerator control wire. Refer to "Adjusting Accelerator Wire" in FE section.



SEM817C

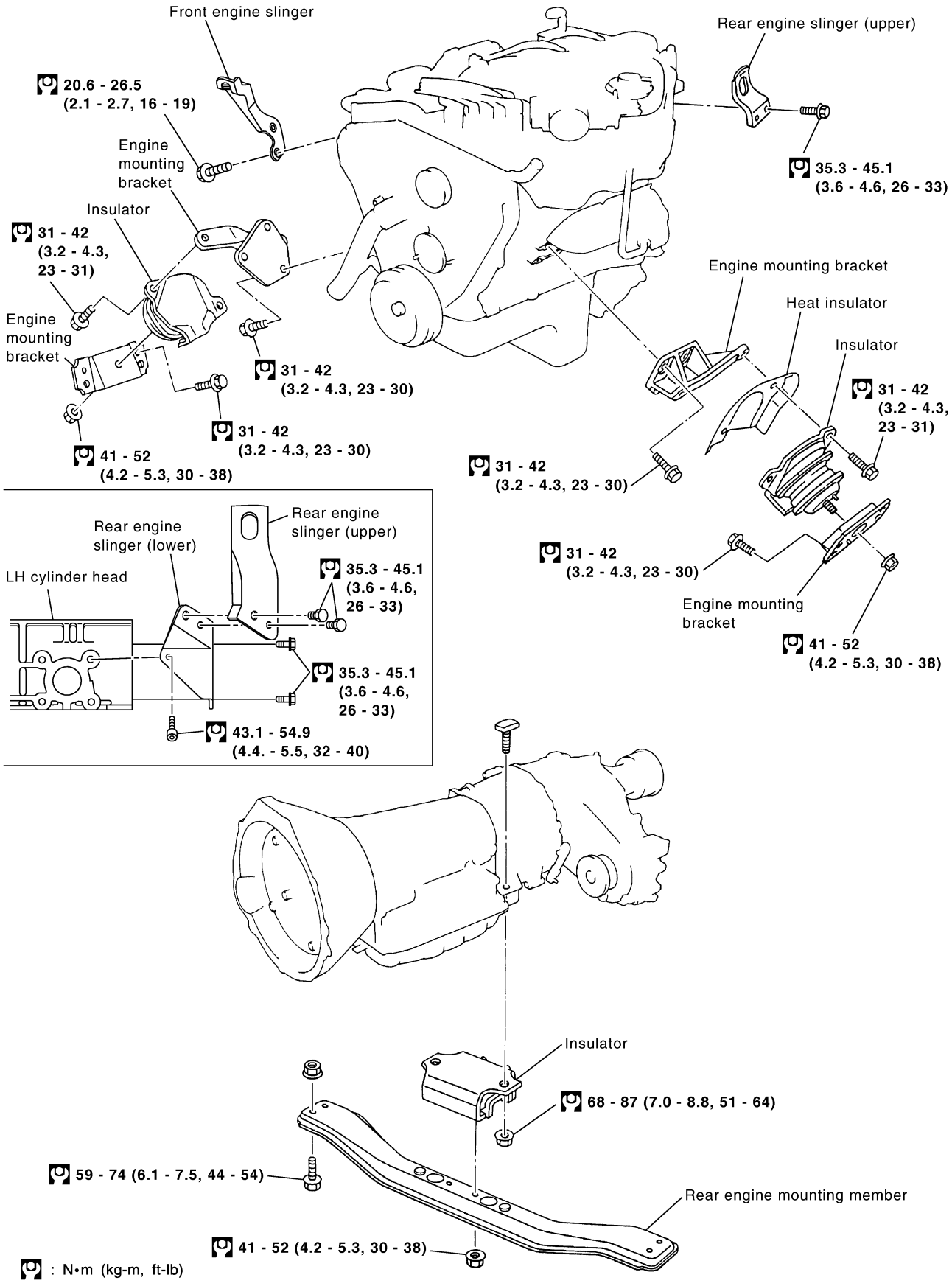
20. Check hydraulic valve lifter.
a. Push plunger forcefully with your finger.
- **Be sure to check it with rocker arm in its free position (not on the lobe).**

b. If valve lifter moves more than 1 mm (0.04 in), air may be inside it.
c. Bleed air off by running engine at 1,000 rpm under no load for about 10 minutes.
d. If hydraulic valve lifters are still noisy, replace them and bleed air off again in the same manner as in step 20 (c).



SEM531A

21. Install remaining parts in reverse order of removal.


Front engine slinger
20.6 - 26.5 (2.1 - 2.7, 16 - 19)
Engine mounting bracket
Insulator
31 - 42 (3.2 - 4.3, 23 - 31)
Engine mounting bracket
31 - 42 (3.2 - 4.3, 23 - 30)
31 - 42 (3.2 - 4.3, 23 - 30)
41 - 52 (4.2 - 5.3, 30 - 38)
Rear engine slinger (upper)
35.3 - 45.1 (3.6 - 4.6, 26 - 33)
Engine mounting bracket
Heat insulator
Insulator
31 - 42 (3.2 - 4.3, 23 - 31)
31 - 42 (3.2 - 4.3, 23 - 30)
31 - 42 (3.2 - 4.3, 23 - 30)
Engine mounting bracket
41 - 52 (4.2 - 5.3, 30 - 38)
Rear engine slinger (lower)
Rear engine slinger (upper)
LH cylinder head
35.3 - 45.1 (3.6 - 4.6, 26 - 33)
35.3 - 45.1 (3.6 - 4.6, 26 - 33)
43.1 - 54.9 (4.4. - 5.5, 32 - 40)
Insulator
68 - 87 (7.0 - 8.8, 51 - 64)
59 - 74 (6.1 - 7.5, 44 - 54)
Rear engine mounting member
41 - 52 (4.2 - 5.3, 30 - 38)
: N•m (kg-m, ft-lb)

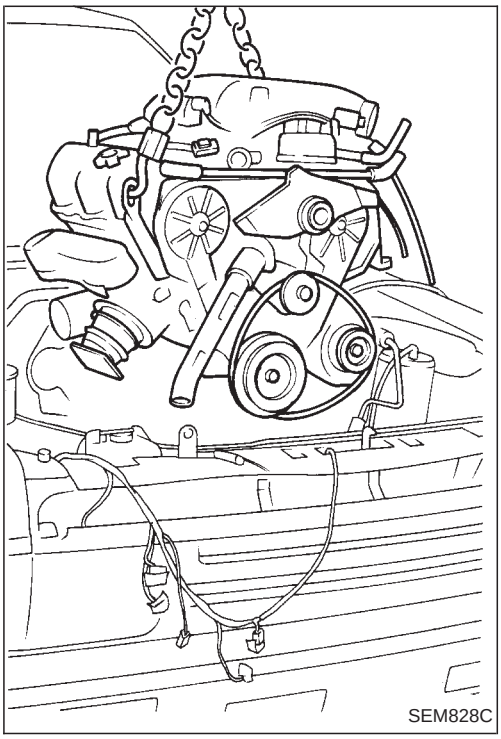
SEM085H

WARNING:

- **Situate vehicle on a flat and solid surface.**
- **Place chocks at front and back of rear wheels.**
- **Do not remove engine until exhaust system has completely cooled off. Otherwise, you may burn yourself and/or fire may break out in fuel line.**
- **For safety during subsequent steps, the tension of wires should be slackened against the engine.**
- **Before disconnecting fuel hose, release fuel pressure from fuel line.**
  Refer to "Fuel Pressure Release" in EC section.
- **Before removing front axle from transmission, place safety stands under designated front supporting points. Refer to GI section for lifting points and tow truck towing.**
- **Be sure to hoist engine and transmission in a safe manner.**
- **For engines not equipped with engine slingers, attach proper slingers and bolts described in PARTS CATALOG.**

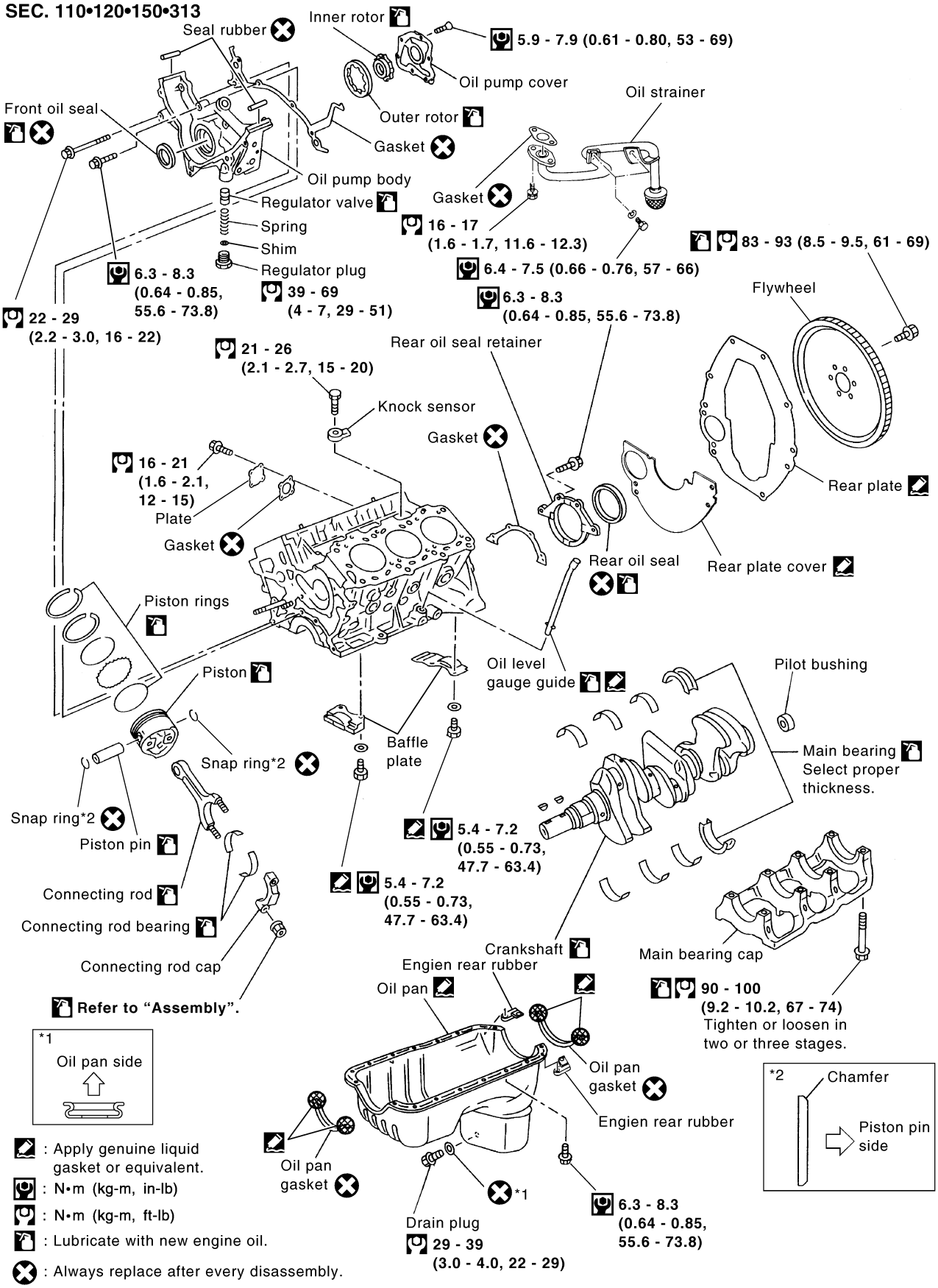
CAUTION:

- **When lifting engine, be careful not to strike adjacent parts, especially accelerator wire casing, brake lines, and brake master cylinder.**
- **In hoisting the engine, always use engine slingers in a safe manner.**


SEM828C

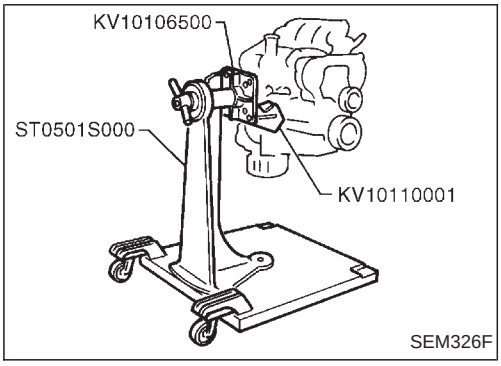
Removal

1. Remove engine undercover and hood. Refer to BT section.
2. Drain engine coolant. Refer to "Changing Engine Coolant" in MA section.
3. Disconnect vacuum hoses, fuel tubes, wires, harnesses and connectors and so on. Refer to EC section.
4. Remove radiator with shroud and cooling fan. Refer to "Radiator" and "Cooling Fan" in LC section.
5. Remove drive belts. Refer to MA section.
6. Remove power steering oil pump and air conditioner compressor. Refer to ST and HA sections.
7. Remove front exhaust tube. Refer to "EXHAUST SYSTEM" in FE section.
8. Remove transmission from vehicle. Refer to MT section.
9. Install engine slingers.
10. Hoist engine with engine slingers and remove engine mounting bolts from both sides.
11. Remove engine from vehicle.


SEC. 110•120•150•313
Seal rubber
Inner rotor
5.9 - 7.9 (0.61 - 0.80, 53 - 69)
Oil pump cover
Front oil seal
Outer rotor
Gasket
Oil pump body
Regulator valve
Spring
Shim
Regulator plug
Oil strainer
Gasket
16 - 17 (1.6 - 1.7, 11.6 - 12.3)
6.4 - 7.5 (0.66 - 0.76, 57 - 66)
83 - 93 (8.5 - 9.5, 61 - 69)
6.3 - 8.3 (0.64 - 0.85, 55.6 - 73.8)
39 - 69 (4 - 7, 29 - 51)
6.3 - 8.3 (0.64 - 0.85, 55.6 - 73.8)
22 - 29 (2.2 - 3.0, 16 - 22)
Flywheel
21 - 26 (2.1 - 2.7, 15 - 20)
Rear oil seal retainer
Knock sensor
Gasket
16 - 21 (1.6 - 2.1, 12 - 15)
Plate
Gasket
Rear plate
Rear oil seal
Rear plate cover
Piston rings
Piston
Oil level gauge guide
Pilot bushing
Baffle plate
Snap ring*2
Main bearing Select proper thickness.
Snap ring*2
Piston pin
5.4 - 7.2 (0.55 - 0.73, 47.7 - 63.4)
5.4 - 7.2 (0.55 - 0.73, 47.7 - 63.4)
Connecting rod
Connecting rod bearing
Crankshaft
Main bearing cap
Connecting rod cap
Engien rear rubber
Oil pan
90 - 100 (9.2 - 10.2, 67 - 74)
Tighten or loosen in two or three stages.
Refer to "Assembly".
*1
Oil pan side
Oil pan gasket
Engien rear rubber
*2
Chamfer
Piston pin side
Oil pan gasket
*1
Drain plug
29 - 39 (3.0 - 4.0, 22 - 29)
6.3 - 8.3 (0.64 - 0.85, 55.6 - 73.8)
: Apply genuine liquid gasket or equivalent.
: N•m (kg-m, in-lb)
: N•m (kg-m, ft-lb)
: Lubricate with new engine oil.
: Always replace after every disassembly.

SEM086H

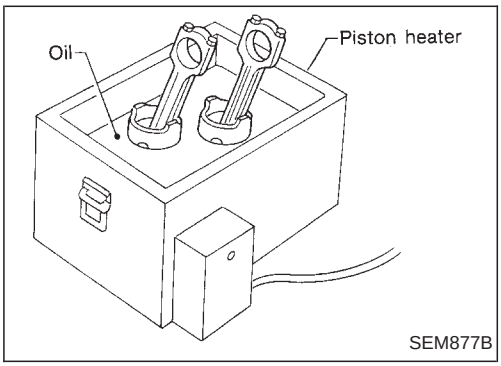
CAUTION:
- **When installing sliding parts such as bearings and pistons, be sure to apply engine oil on the sliding surfaces.**
- **Place removed parts such as bearings and bearing caps in their proper order and direction.**
- **When installing connecting rod bolts and main bearing cap bolts, apply new engine oil to threads and seating surfaces.**



Disassembly

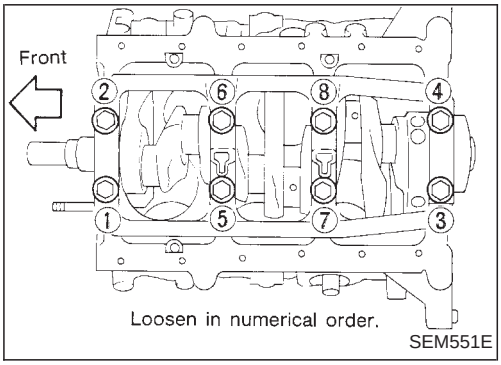
PISTON AND CRANKSHAFT

1. Place engine on a work stand (SST).
2. Drain engine coolant and engine oil. Refer to “Changing Engine Oil” and “Changing Engine Coolant” in MA section.
3. Remove oil pan and oil pump. Refer to EM-14, “Removal”.
4. Remove timing belt. Refer to “Checking Drive Belts” in MA section.
5. Remove water pump. Refer to “Water Pump” in LC section.
6. Remove cylinder head. Refer to EM-29, “Removal”.



7. Remove pistons with connecting rods.
- When disassembling piston and connecting rod, remove snap ring first, then heat piston to 60 to 70°C (140 to 158°F) or use piston pin press stand at room temperature.

CAUTION:
- **When piston rings are not replaced, make sure that piston rings are mounted in their original position and direction.**
- **When replacing piston rings, install them with the punchmark facing up. If there is no punchmark, install with either side up.**

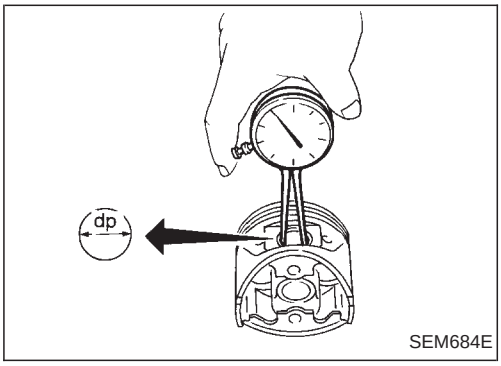


8. Remove bearing cap and crankshaft.
- **Before removing bearing cap, measure crankshaft end play. Refer to EM-57, “CRANKSHAFT”.**

CAUTION:
The bearing cap bolts should be loosened in two or three steps in numerical order as shown.

9. Remove knock sensor.

CAUTION:
Handle the sensor carefully and avoid impact to it.

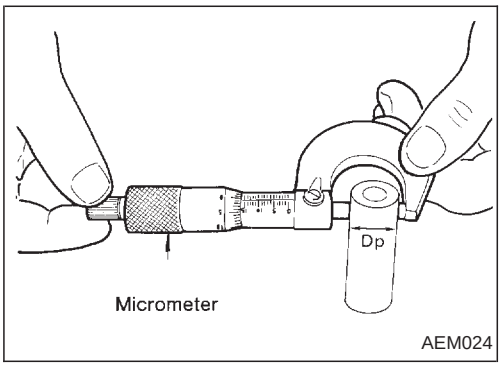


Inspection

PISTON AND PISTON PIN CLEARANCE

1. Measure inner diameter of piston pin hole “dp” as shown.
   Standard diameter “dp”:
   20.969 - 20.981 mm (0.8255 - 0.8260 in)

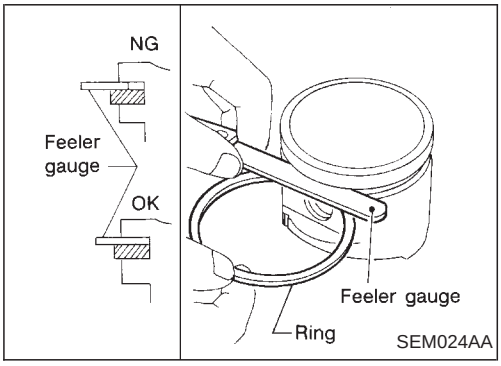
Inspection (Cont'd)



2. Measure outer diameter of piston pin "Dp" as shown.
   Standard diameter "Dp":
   20.971 - 20.983 mm (0.8256 - 0.8261 in)
3. Calculate piston pin clearance.
   dp − Dp = 0 - 0.004 mm (0 - 0.0002 in)

If the clearance is out of specification, replace piston assembly with pin.

PISTON RING SIDE CLEARANCE

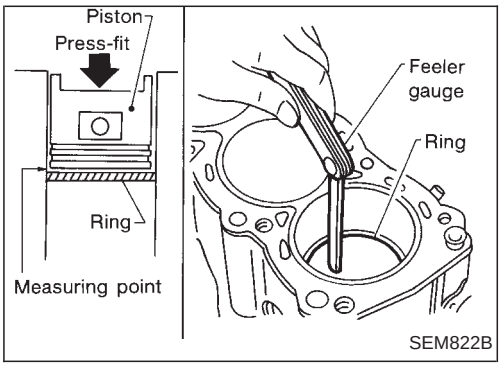


Measure the piston ring to piston side clearance as shown.

Side clearance:
Top ring: 0.024 - 0.076 mm (0.0009 - 0.0030 in)
2nd ring: 0.030 - 0.070 mm (0.0012 - 0.0028 in)
Oil ring:
0.015 - 0.190 mm (0.0006 - 0.0075 in)
Max. limit of side clearance:
Top ring: 0.11 mm (0.0043 in)
2nd ring: 0.10 mm (0.0039 in)

If out of specification, replace piston and/or piston ring assembly.

PISTON RING END GAP

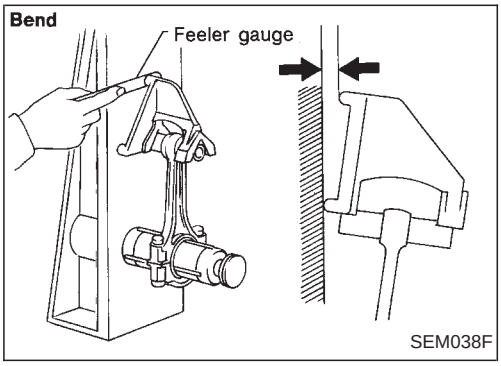


With the piston ring on top of the piston, insert the piston and ring into the cylinder bore as shown. Measure the piston ring gap.

End gap:
Top ring: 0.21 - 0.40 mm (0.0083 - 0.0157 in)
2nd ring: 0.50 - 0.69 mm (0.0197 - 0.0272 in)
Oil ring: 0.20 - 0.69 mm (0.0079 - 0.0272 in)
Max. limit of ring gap:
Top ring: 0.54 mm (0.0213 in)
2nd ring: 0.80 mm (0.0315 in)
Oil ring: 0.95 mm (0.0374 in)

If out of specification, replace piston ring. If gap still exceeds the limit even with a new ring, rebore cylinder and use oversized piston and piston rings. Refer to EM-67, "Piston ring".

CAUTION:
When replacing the piston, check the cylinder block surface for scratches or seizure. If scratches or seizure is found, hone or replace the cylinder block.

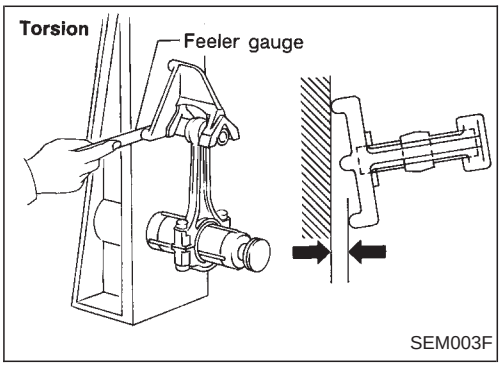


CONNECTING ROD BEND AND TORSION

Bend:
Limit 0.15 mm (0.0059 in)
per 100 mm (3.94 in) length
Torsion:
Limit 0.30 mm (0.0118 in)
per 100 mm (3.94 in) length

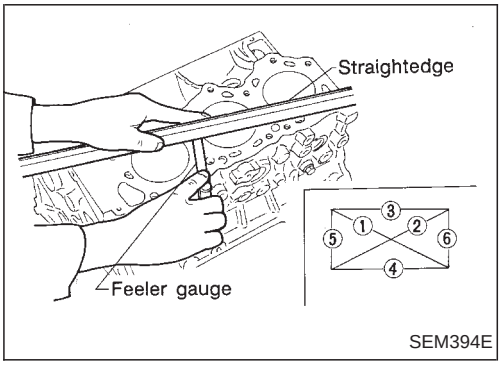
If it exceeds the limit, replace connecting rod assembly.

Inspection (Cont'd)



CYLINDER BLOCK DISTORTION AND WEAR

1. Clean upper face of cylinder block and measure the distortion.
   Limit:
   0.10 mm (0.0039 in)



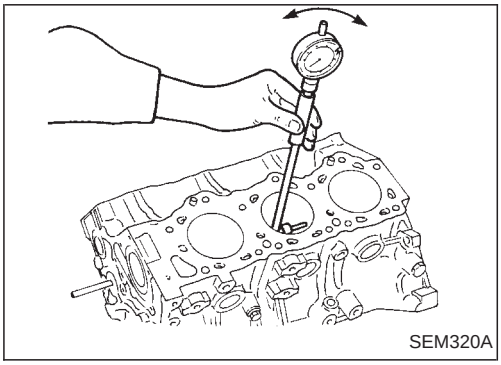
2. If out of specification, resurface the cylinder block sealing surface.
   The resurfacing limit is determined by cylinder head resurfacing required.

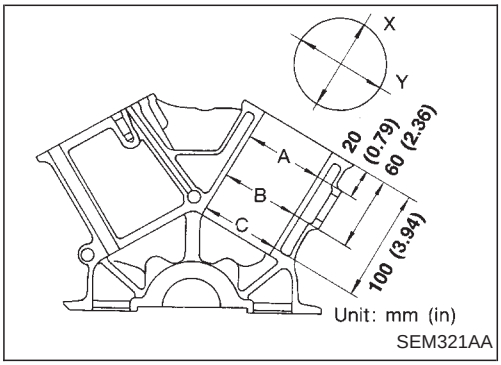
Amount of cylinder head resurfacing is "A".
Amount of cylinder block resurfacing is "B".
The maximum limit is as follows:
A + B = 0.2 mm (0.008 in)
Nominal cylinder block height from crankshaft center:
227.60 - 227.70 mm (8.9606 - 8.9645 in)

3. If necessary, replace cylinder block.

PISTON-TO-BORE CLEARANCE

1. Using a bore gauge, measure cylinder bore for wear, out-of-round and taper.



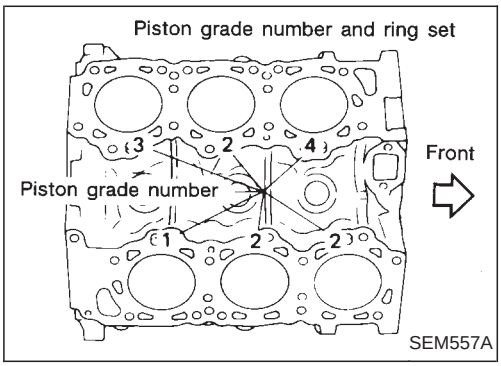


Out-of-round (difference between X and Y) standard:
0.015 mm (0.0006 in)
Taper (difference between A and C) standard:
0.015 mm (0.0006 in)

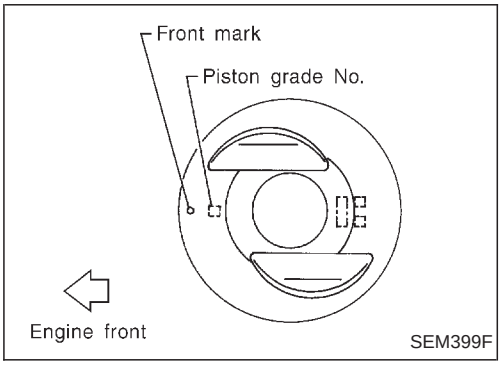
If it exceeds the limit, rebore all cylinders. Replace cylinder block if necessary. Refer to EM-66, "CYLINDER BLOCK".

2. Check for scratches and seizure. If seizure is found, hone it.

Inspection (Cont'd)

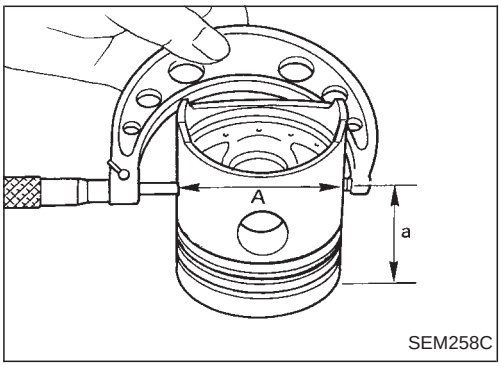


- **If both cylinder block and piston are replaced with new ones, select piston of the same grade number punched on cylinder block upper surface. Refer to EM-67, "Available piston".**



Combination grade number for cylinder bore and piston

	For No. 3, 4 and 5 cylinders						Except for No. 1, 2 and 6 cylinders		
Cylinder bore grade No.	1	2	3	4	5	6	1	2	3
Piston grade No.	2-1	3-2	3-3	4-4	4-5	5-6	1	2	3



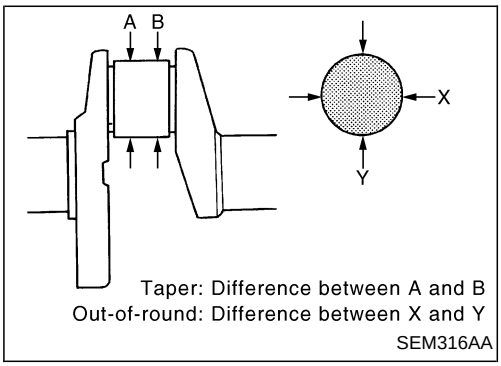
3. Measure piston skirt diameter.
   Piston diameter "A":
   Refer to EM-67, "Available piston".
   Measuring point "a" (Distance from the top):
   49.0 mm (1.929 in)
4. Make sure piston-to-bore clearance is within specification.
   Piston-to-cylinder bore clearance "B":
   Standard
   No. 1, 2 and 6 cylinders: 0.025 - 0.045 mm (0.0010 - 0.0018 in)
   No. 3 and 4 cylinders: 0.015 - 0.025 mm (0.0006 - 0.0010 in)
   No. 5 cylinder: 0.030 - 0.040 mm (0.0012 - 0.0016 in)
5. Determine piston oversize according to amount of cylinder wear. Oversize pistons are available for service. Refer to EM-67, "Available piston".
6. Cylinder bore size is determined by adding piston-to-bore clearance to piston diameter "A".
   Rebored size calculation:
   D = A + B − C
   where,
   D: Bored diameter
   A: Piston diameter as measured
   B: Piston-to-bore clearance
   C: Honing allowance 0.02 mm (0.0008 in)
7. Install main bearing caps, and tighten to the specified torque to prevent distortion of cylinder bores in final assembly.
8. Cut cylinder bores.

- **When any cylinder needs boring, all other cylinders must also be bored.**
- **Do not cut too much out of cylinder bore at a time. Cut only 0.05 mm (0.0020 in) or so in diameter at a time.**

9. Hone cylinders to obtain specified piston-to-bore clearance.
10. Measure finished cylinder bore for out-of-round and taper.

- **Measurement should be done after cylinder bore cools down.**

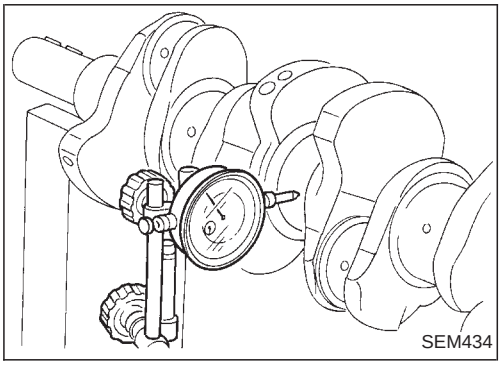
Inspection (Cont'd)



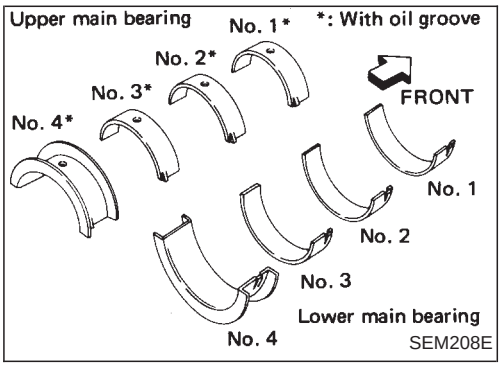
Taper: Difference between A and B
Out-of-round: Difference between X and Y
SEM316AA

CRANKSHAFT

1. Check crankshaft main and pin journals for score, wear or cracks.
2. With a micrometer, measure journals for taper and out-of-round.
   Out-of-round (difference between X and Y):
   Less than 0.005 mm (0.0002 in)
   Taper (difference between A and B):
   Less than 0.005 mm (0.0002 in)


SEM434

3. Measure crankshaft runout.
- Place a V-block on a precise flat table to support the journals on the both end of the crankshaft.
- Place a dial gauge straight up on the No. 3 journal.
- While rotating the crankshaft, read the movement of the pointer on the dial gauge. (Total indicator reading)
  Runout (Total indicator reading):
  Less than 0.10 mm (0.0039 in)



SEM208E

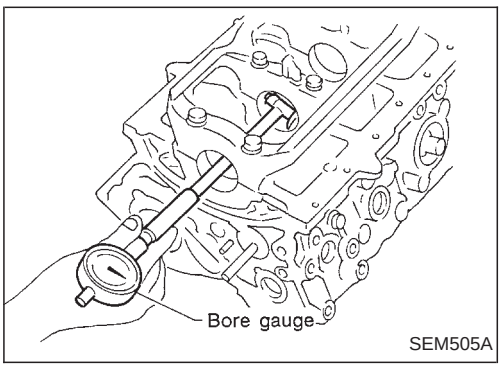
BEARING CLEARANCE

NOTE:
Either of the following two methods may be used, however, method A gives more reliable results and is preferable.

Method A (Using bore gauge & micrometer)

Main bearing

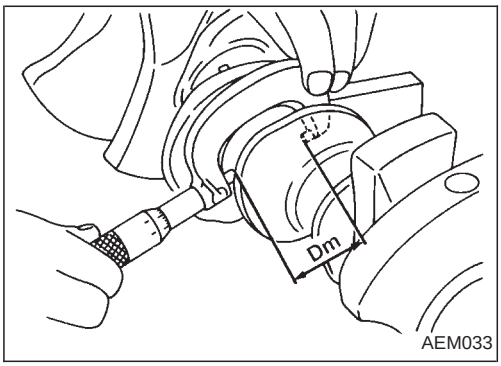
1. Set main bearings in their proper positions on cylinder block and main bearing cap.
2. Install main bearing cap to cylinder block.
   Tighten all bolts in correct order in two or three stages. Refer to EM-57, "CRANKSHAFT".



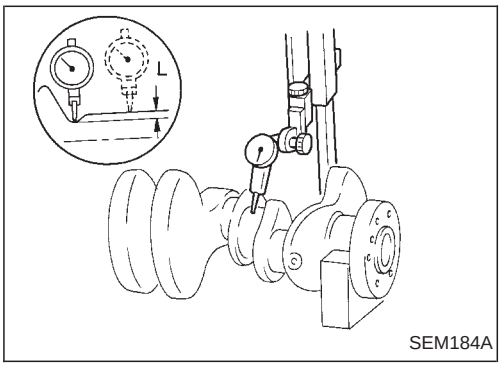
SEM505A

3. Measure inner diameter "A" of each main bearing as shown.

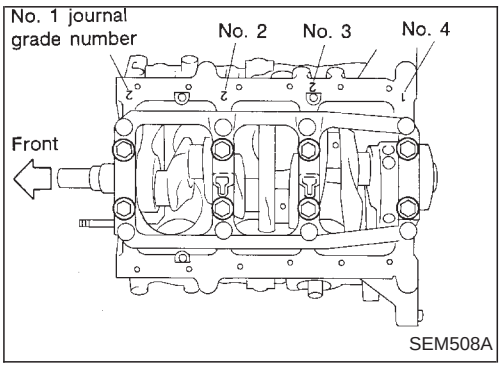
Inspection (Cont'd)



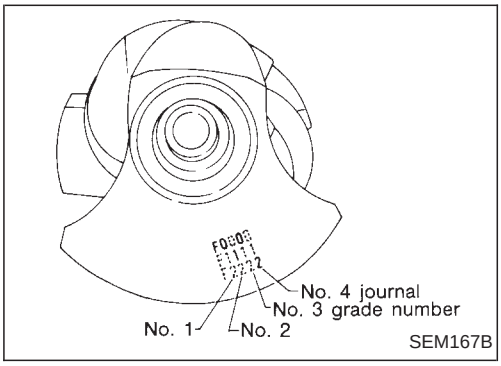
4. Measure outer diameter "Dm" of each crankshaft main journal as shown.
5. Calculate main bearing clearance.
   No. 1 main bearing clearance (A − Dm):
   Standard
   0.030 - 0.048 mm (0.0012 - 0.0019 in)
   Limit
   0.060 mm (0.0024 in)
   No. 2, 3 and No. 4 main bearing clearance (A − Dm):
   Standard
   0.038 - 0.065 mm (0.0015 - 0.0026 in)
   Limit
   0.080 mm (0.0031 in)
6. If it exceeds the limit, replace bearing.
7. If clearance cannot be adjusted within the standard of any bearing, grind crankshaft journal and use undersized bearing.



a. When grinding crankshaft journal, confirm that "L" dimension in fillet roll is more than the specified limit.
   "L": 0.1 mm (0.004 in)
b. As necessary, grind the crankshaft journals to specification, or replace with an available service part. Refer to EM-57, "CRANKSHAFT".



8. If crankshaft is reused, measure main bearing clearances and select thickness of main bearings.
   If crankshaft is replaced with a new one, it is necessary to select thickness of main bearings as follows:
a. Grade number of each cylinder block main journal is punched on the respective cylinder block. These numbers are punched in either Arabic or Roman numerals.



b. Grade number of each crankshaft main journal is punched on the respective crankshaft. These numbers are punched in either Arabic or Roman numerals.
c. Select main bearing with suitable thickness according to the following example or table.

Inspection (Cont'd)

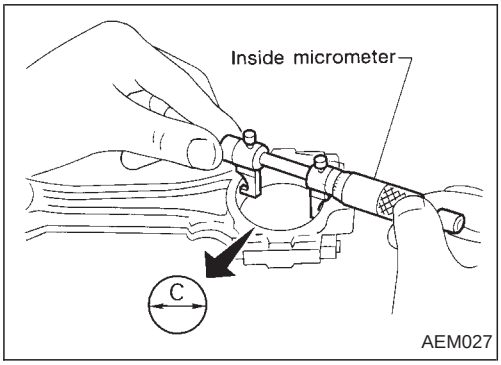
Main bearing grade number
No. 1 main bearing
(Identification color):

Crankshaft main journal grade number	Cylinder block main journal grade number			
	3	4	5	6
3	0 (Black)	1 (Brown)	2 (Green)	3 (Yellow)
4	1 (Brown)	2 (Green)	3 (Yellow)	4 (Blue)
5	2 (Green)	3 (Yellow)	4 (Blue)	5 (Pink)
6	3 (Yellow)	4 (Blue)	5 (Pink)	6 (Purple)

No. 2, 3 and No. 4 main bearings
(Identification color):

		Main journal grade number		
		0	1	2
Crankshaft journal grade number	0	0 (Black)	1 (Brown)	2 (Green)
	1	1 (Brown)	2 (Green)	3 (Yellow)
	2	2 (Green)	3 (Yellow)	4 (Blue)

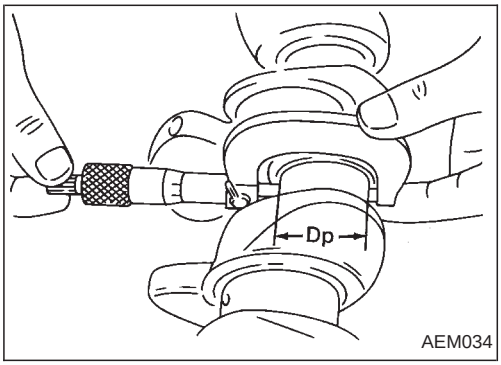
For example:
Main journal grade number: 1
Crankshaft journal grade number: 2
Main bearing grade number = 1 + 2 = 3 (Yellow)



AEM027

Connecting rod bearing (Big end)

1. Install connecting rod bearing to connecting rod big end and cap.
2. Install connecting rod cap to connecting rod. Tighten bolts to the specified torque. Refer to EM-57, "CRANKSHAFT".
3. Measure inner diameter "C" of each bearing installed in the connecting rod big end.

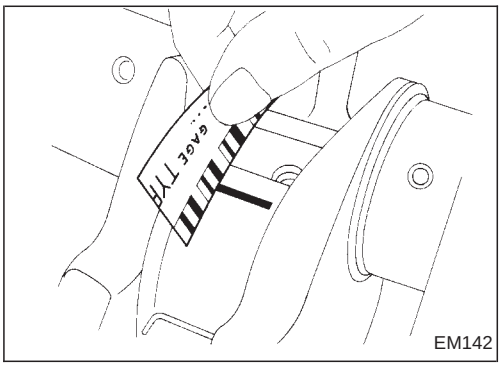


AEM034

4. Measure outer diameter "Dp" of each crankshaft pin journal.
5. Calculate connecting rod bearing clearance.
   Connecting rod bearing clearance (C − Dp):
   Standard
   0.014 - 0.054 mm (0.0006 - 0.0021 in)
   Limit
   0.090 mm (0.0035 in)
6. If it exceeds the limit, replace the connecting rod bearing.
7. If clearance cannot be adjusted within the standard of any bearing, grind crankshaft journal and use undersized bearing. Refer to EM-53, "Main bearing".

Inspection (Cont'd)

Method B (Using plastigage)

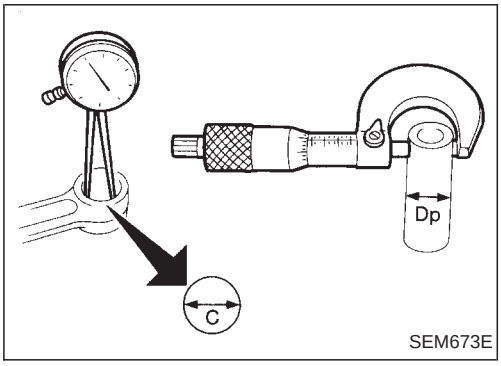


EM142

CAUTION:

- **Do not turn crankshaft or connecting rod while plastigage is being inserted.**
- **When bearing clearance exceeds the specified limit, ensure that the proper bearing has been installed. Then if excessive bearing clearance exists, use a thicker main bearing or undersized bearing so that the specified bearing clearance is obtained.**

CONNECTING ROD BUSHING CLEARANCE (Small end)



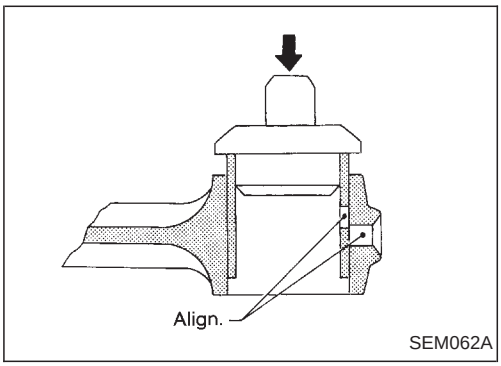
SEM673E

1. Measure inner diameter "C" of the connecting rod small end.
2. Measure outer diameter "Dp" of piston pin bushing.
3. Calculate connecting rod bushing clearance.

Connecting rod bushing clearance = C − Dp
Standard: 0.005 - 0.017 mm (0.0002 - 0.0007 in)
Limit: 0.023 mm (0.0009 in)

If it exceeds the limit, replace connecting rod assembly or connecting rod bushing and/or piston set with pin.

REPLACEMENT OF CONNECTING ROD BUSHING (Small end)



SEM062A

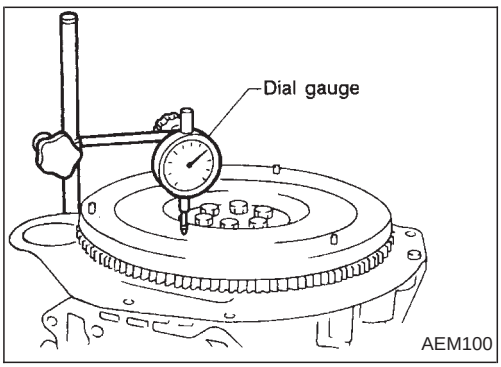
1. Drive in small end bushing into the rod until it is flush with end surface of rod.

CAUTION:

Be sure to align the oil holes.

2. After driving in small end bushing, ream the bushing so that clearance between connecting rod bushing and piston pin is the specified value.

Clearance between connecting rod bushing and piston pin:
0.005 - 0.017 mm (0.0002 - 0.0007 in)



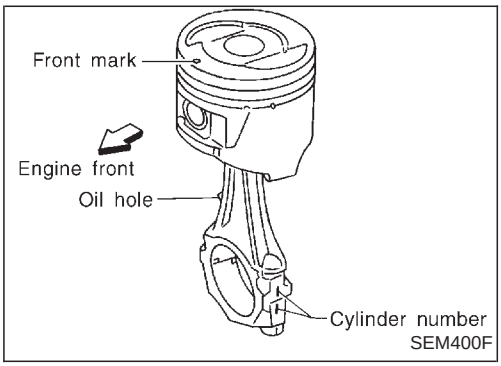
AEM100

FLYWHEEL/DRIVE PLATE RUNOUT

Runout (Total indicator reading):
Flywheel
Less than 0.15 mm (0.0059 in)

CAUTION:

Do not surface flywheel. Replace as necessary.

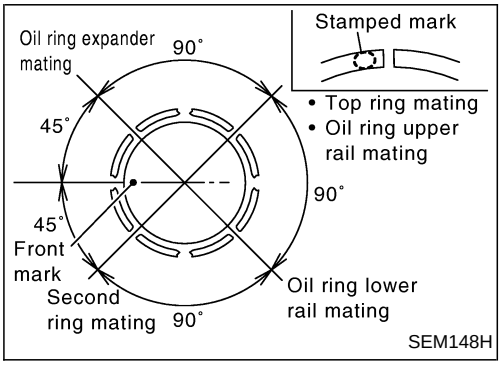


Assembly

PISTON

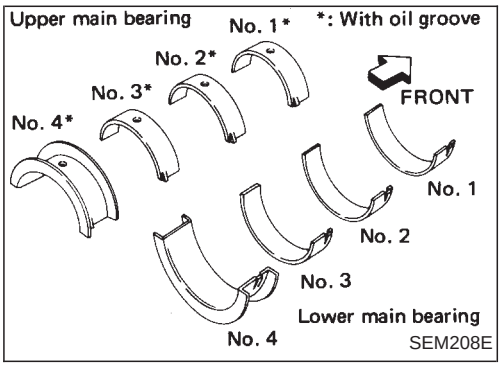
1. Install new snap ring on one side of piston pin hole.
2. Heat piston to 60 to 70°C (140 to 158°F) and assemble piston, piston pin, connecting rod and new snap ring.

- **Align the direction of piston and connecting rod.**
- **Numbers stamped on connecting rod and cap correspond to each cylinder.**
- **After assembly, make sure connecting rod swings smoothly.**



3. Set piston rings as shown.

- Install the second ring with the stamped surface facing upward.
  Standard mark: 2 N (second ring)

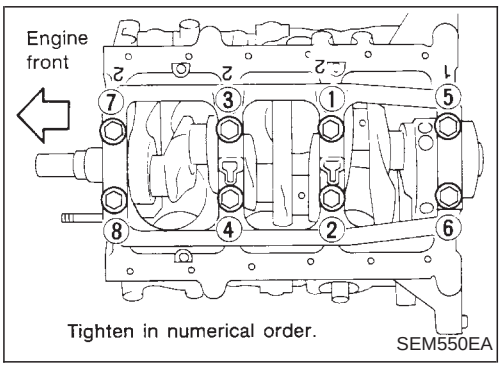


CRANKSHAFT

1. Set main bearings in their proper positions on cylinder block and main bearing cap.

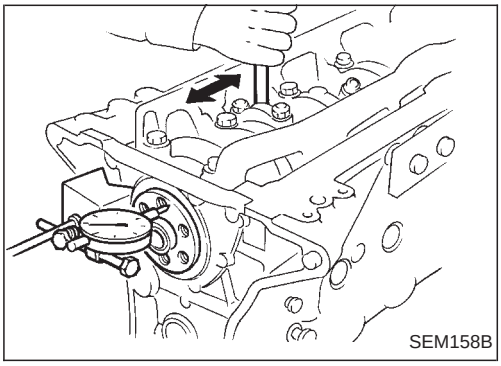
- **Confirm that correct main bearings are used.**

Refer to EM-53, “BEARING CLEARANCE”.



2. Install crankshaft and main bearing caps and tighten bolts to the specified torque.

- **Prior to tightening bearing cap bolts, place bearing cap in its proper position by shifting crankshaft in the axial direction.**
- **Tighten bearing cap bolts gradually in two or three stages. Start with center bearing and move outward sequentially.**
- **After securing bearing cap bolts, make sure crankshaft turns smoothly by hand.**
- **Lubricate threads and seat surfaces of the bolts with new engine oil.**

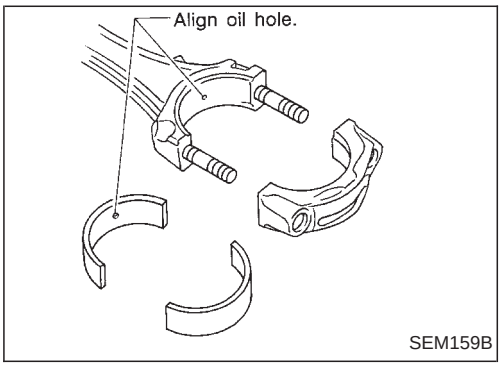


3. Measure crankshaft end play.

Crankshaft end play:
Standard
0.050 - 0.170 mm (0.0020 - 0.0067 in)
Limit
0.30 mm (0.0118 in)

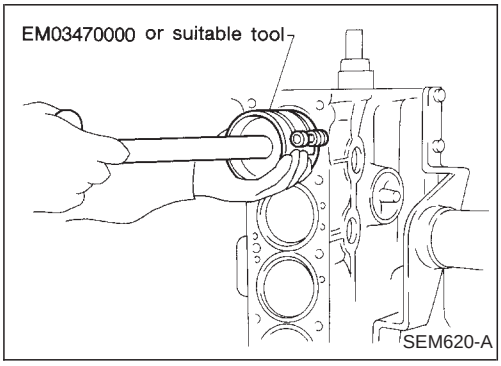
If beyond the limit, replace No. 4 bearing with a new one.

Assembly (Cont'd)



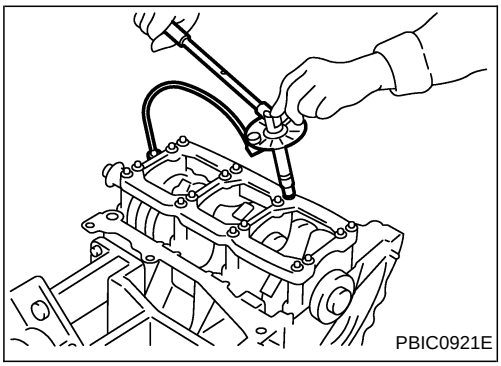
4. Install connecting rod bearings in connecting rods and connecting rod caps.
- **Confirm that correct bearings are used.**

Refer to EM-55, "Connecting rod bearing (Big end)".
- Install bearings so that oil hole in connecting rod aligns with oil hole of bearing as shown.



5. Install pistons with connecting rods using SST or suitable tool as shown.

a. Install them into corresponding cylinders with SST or suitable tool.
- **Be careful not to scratch cylinder wall by connecting rod.**
- **Arrange so that front mark on piston head faces toward front of engine.**



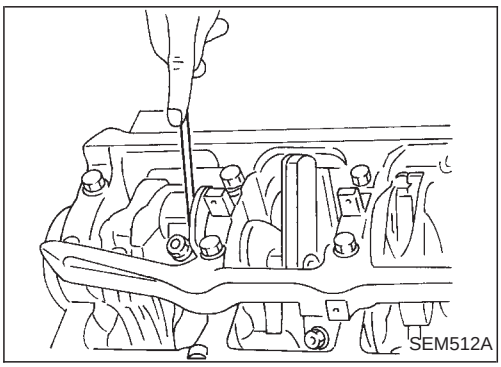
b. Install connecting rod bearing caps.
- **Lubricate threads and seat surfaces with new engine oil.**

Tighten connecting rod bearing cap nuts to the specified torque.

: Connecting rod bearing nut

(1) Tighten to 14 to 16 N·m (1.4 to 1.6 kg-m, 10 to 12 ft-lb).

(2) Turn nuts 60 to 65 degrees clockwise.
If an angle wrench is not available, tighten nuts to 38 to 44 N·m (3.9 to 4.5 kg-m, 28 to 33 ft-lb).



6. Measure connecting rod side clearance.

Connecting rod side clearance:

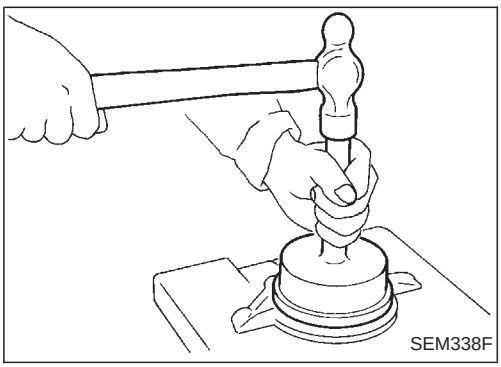
Standard

0.20 - 0.35 mm (0.0079 - 0.0138 in)

Limit

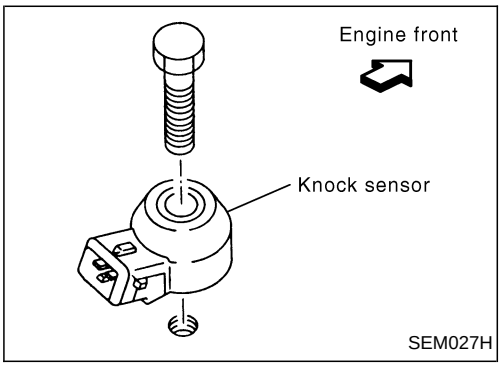
0.40 mm (0.0157 in)

If beyond the limit, replace connecting rod and/or crankshaft.



7. Install rear oil seal retainer.
- Install new rear oil seal before installing rear oil seal retainer.

Assembly (Cont'd)



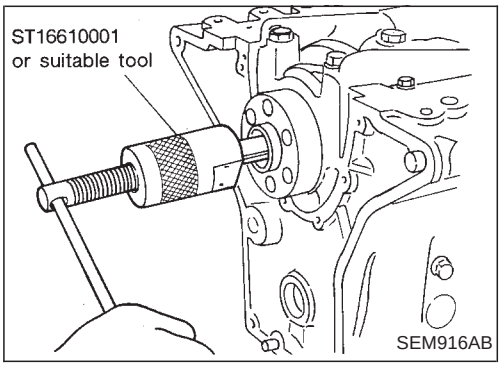
KNOCK SENSOR

1. Install knock sensor.
- Make sure that there is no foreign material on the cylinder block mating surface and the back surface of the knock sensor.
- Install knock sensor so that connector faces rear of engine.
- Do not tighten the mounting bolts while holding the connector.
- Make sure that the knock sensor does not interfere with other parts.

CAUTION:

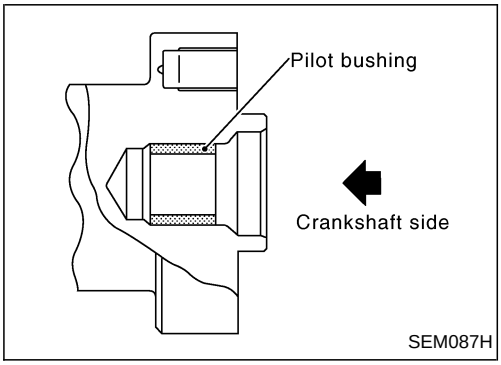
If any impact by dropping is applied to the knock sensor, replace it with new one.

- After installing knock sensor, connect sub-harness, and lay it out to rear of engine.



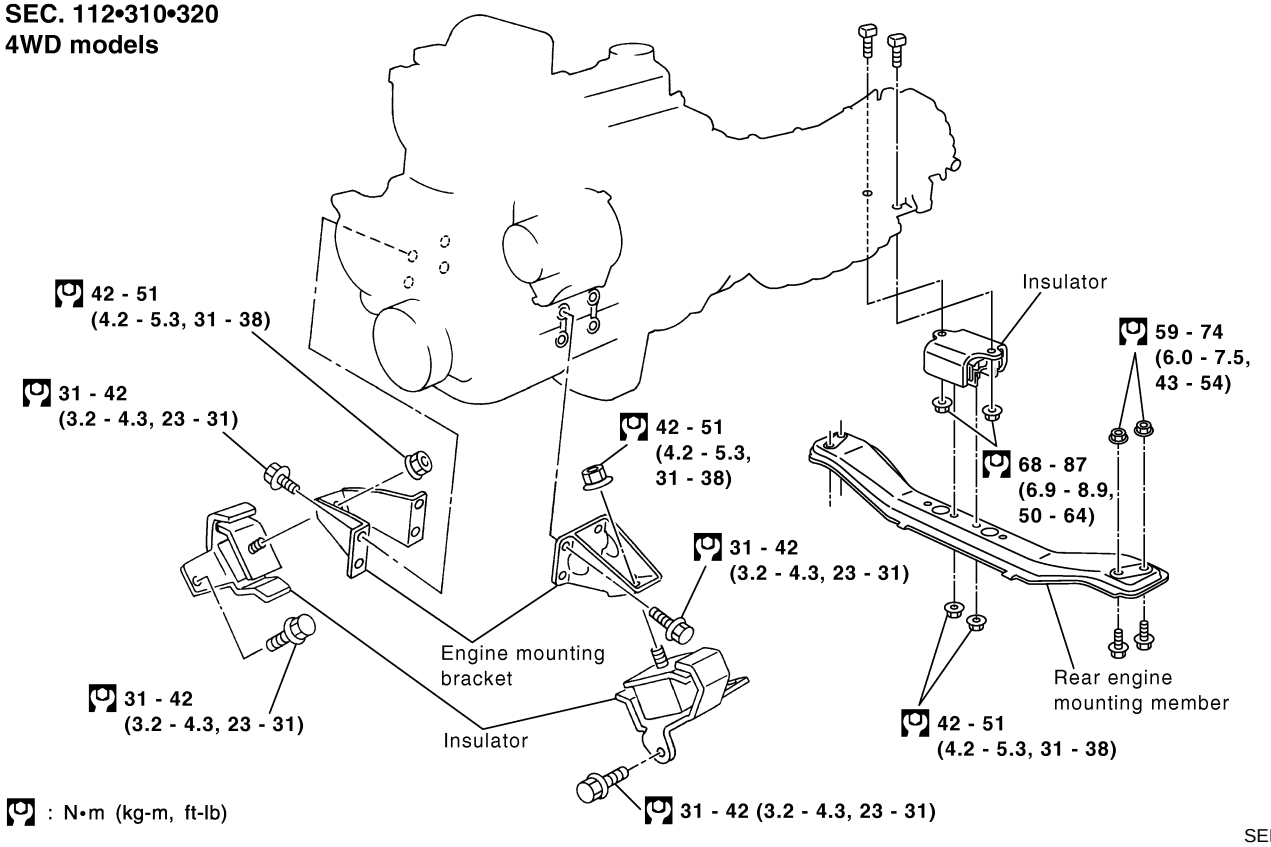
REPLACING PILOT BUSHING

1. Remove pilot bushing using SST or suitable tool as shown.



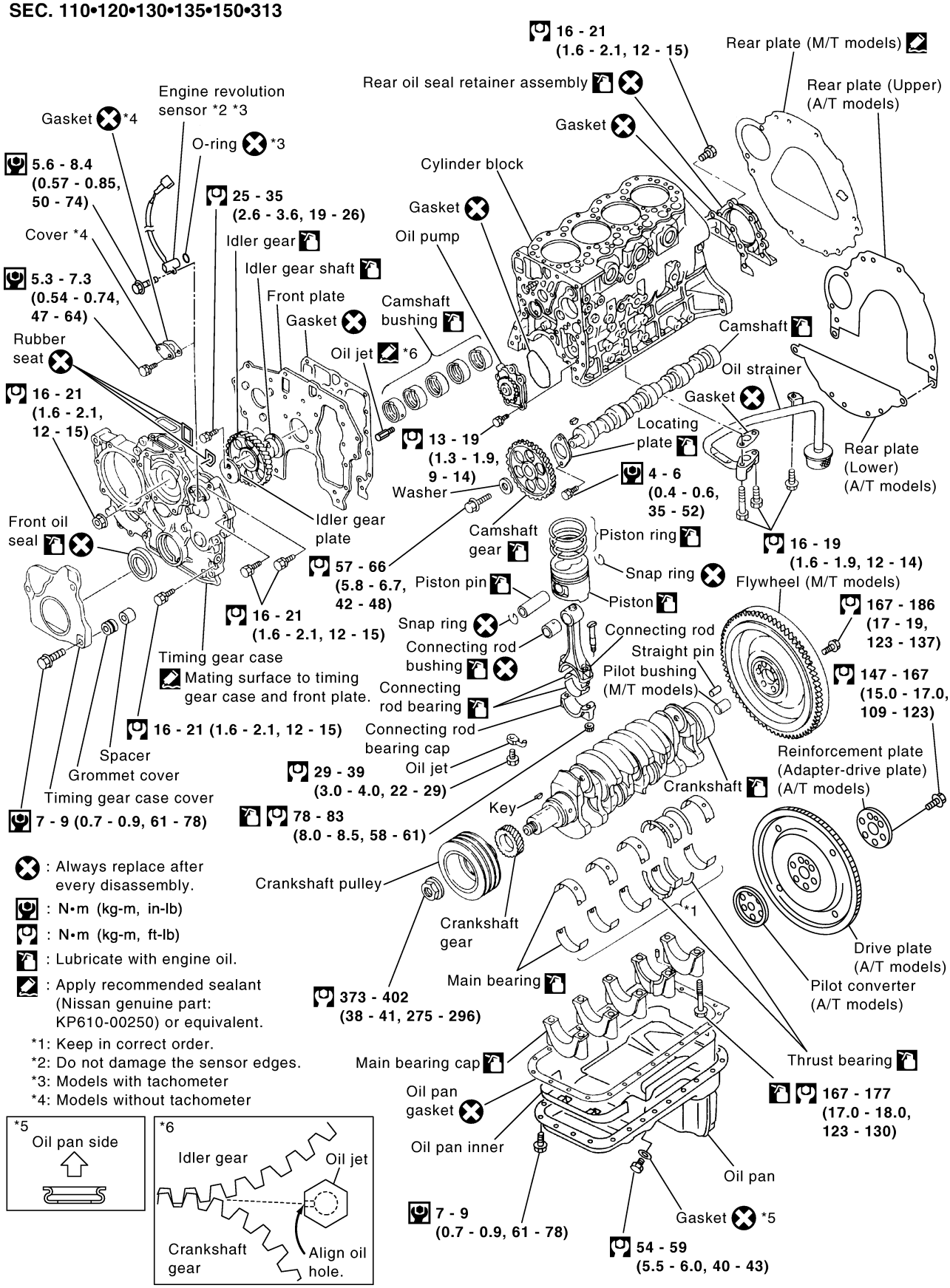
2. Install pilot bushing as shown using suitable drift.

SEC. 112•310•320
4WD models

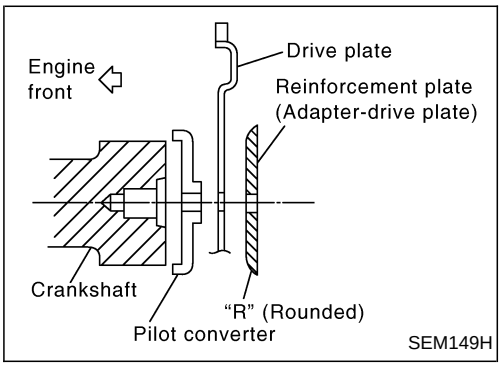


SEM150H

SEC. 110•120•130•135•150•313



SEM151H



Assembly

Drive plate assembly (A/T models)

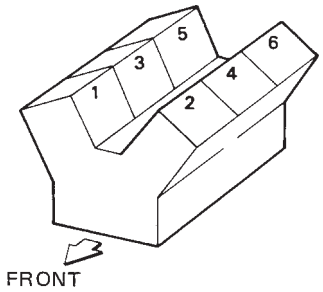
Install drive plate as follows:

- Install reinforcement plate so that the peripheral area "R" faces drive plate side.
- Fix crankshaft with a ring gear stopper (SST).
- Tighten mounting bolts diagonally in several steps.

General Specifications

Cylinder arrangement		V-6
Displacement	cm^3 (cu in)	3,275 (199.84)
Bore and stroke	mm (in)	91.5 x 83 (3.602 x 3.27)
Valve arrangement		OHC
Firing order		1-2-3-4-5-6
Number of piston rings		
Compression		2
Oil		1
Number of main bearings		4
Compression ratio		8.9

Cylinder number

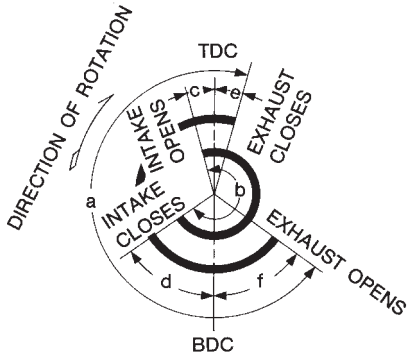


SEM713A

Unit: kPa (bar, kg/cm^2, psi)/300 rpm

Compression pressure	
Standard	1,196 (11.96, 12.2, 173)
Minimum	883 (8.83, 9.0, 128)
Differential limit between cylinders	98 (0.98, 1.0, 14)

Valve timing



EM120

Unit: degree

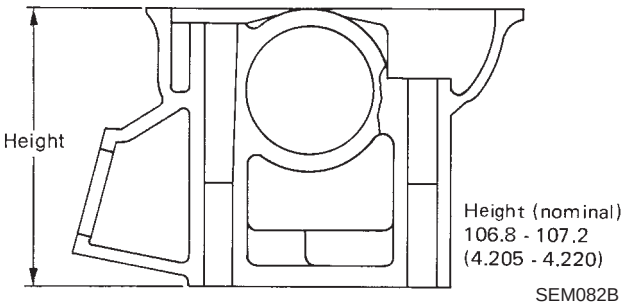
a	b	c	d	e	f
240	244	4	60	9	51

Inspection and Adjustment

CYLINDER HEAD

Unit: mm (in)

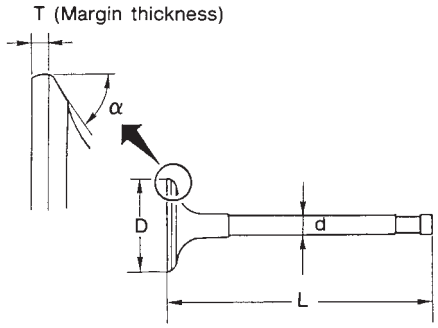
	Standard	Limit
Head surface distortion	Less than 0.03 (0.0012)	0.1 (0.004)



SEM082B

VALVE

Unit: mm (in)



SEM188

Valve head diameter "D"	
Intake	41.95 - 42.25 (1.6516 - 1.6634)
Exhaust	34.95 - 35.25 (1.3760 - 1.3878)
Valve length "L"	
Intake	124.15 - 124.45 (4.8878 - 4.8996)
Exhaust	122.85 - 123.15 (4.8366 - 4.8484)
Valve stem diameter "d"	
Intake	6.965 - 6.980 (0.2742 - 0.2748)
Exhaust	7.962 - 7.970 (0.3135 - 0.3138)
Valve seat angle "α"	
Intake	45°15′ - 45°45′
Exhaust	
Valve margin "T"	
Intake	1.15 - 1.45 (0.0453 - 0.0571)
Exhaust	1.35 - 1.65 (0.0531 - 0.0650)
Valve margin "T" limit	More than 0.5 (0.020)
Valve stem end surface grinding limit	Less than 0.2 (0.008)
Valve clearance	
Intake	0 (0)
Exhaust	0 (0)

Valve spring

Free height	mm (in)	50.47 (1.9870)
Pressure N (kg, lb) at height mm (in)	Installation	349 - 380 (35.6 - 38.8, 78.5 - 85.4) at 40.0 (1.575)
	Valve open	770 - 837 (78.5 - 85.4, 173.1 - 188.2) at 30.0 (1.181)
Out-of-square	mm (in)	2.0 (0.079)

Hydraulic valve lifter

Unit: mm (in)

Lifter outside diameter	15.947 - 15.957 (0.6278 - 0.6282)
Lifter guide inside diameter	16.000 - 16.013 (0.6299 - 0.6304)
Clearance between lifter and lifter guide	0.043 - 0.066 (0.0017 - 0.0026)

Valve guide

Unit: mm (in)

		Standard	Service
Valve guide Outer diameter	Intake	11.023 - 11.034 (0.4340 - 0.4344)	11.223 - 11.234 (0.4418 - 0.4423)
	Exhaust	12.023 - 12.034 (0.4733 - 0.4738)	12.223 - 12.234 (0.4812 - 0.4817)
Valve guide Inner diameter (Finished size)	Intake	7.000 - 7.018 (0.2756 - 0.2763)	
	Exhaust	8.000 - 8.018 (0.3150 - 0.3157)	
Cylinder head valve guide hole diameter	Intake	10.975 - 10.996 (0.4321 - 0.4329)	11.175 - 11.196 (0.4400 - 0.4408)
	Exhaust	11.975 - 11.996 (0.4715 - 0.4723)	12.175 - 12.196 (0.4793 - 0.4802)
Interference fit of valve guide	Intake	0.027 - 0.059 (0.0011 - 0.0023)	
	Exhaust		
		Standard	Max. tolerance
Valve to valve guide clearance	Intake	0.020 - 0.053 (0.0008 - 0.0021)	0.10 (0.0039)
	Exhaust	0.030 - 0.049 (0.0012 - 0.0019)	
Valve deflection limit		—	0.20 (0.0079)

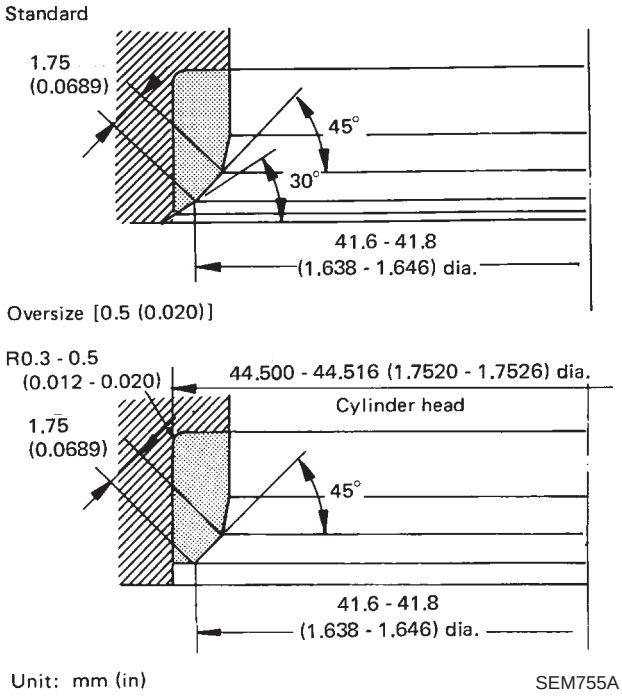
Rocker shaft and rocker arm

Unit: mm (in)

Rocker shaft Outer diameter	17.979 - 18.000 (0.7078 - 0.7087)
Rocker arm Inner diameter	18.007 - 18.028 (0.7089 - 0.7098)
Clearance between rocker arm and rocker shaft	0.007 - 0.040 (0.0003 - 0.0016)

Inspection and Adjustment (Cont'd)

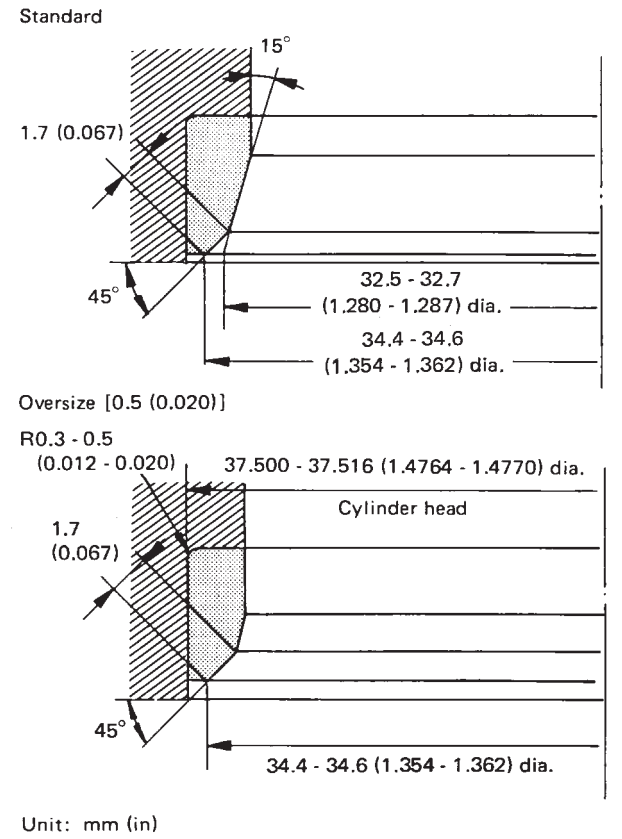
Intake valve seat



Unit: mm (in)

SEM755A

Exhaust valve seat

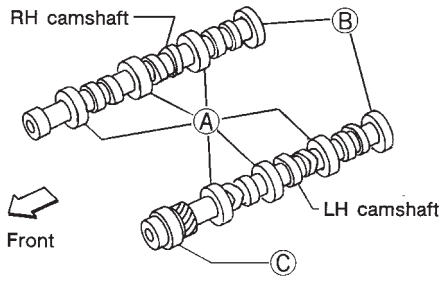


Unit: mm (in)

SEM756A

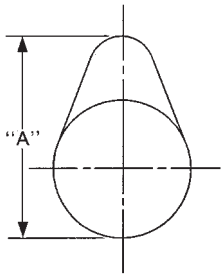
CAMSHAFT AND CAMSHAFT BEARING

Unit: mm (in)



SEM893BA

		Standard	Max. tolerance
Camshaft journal to bearing clearance		0.060 - 0.105 (0.0024 - 0.0041)	0.15 (0.0059)
Inner diameter of camshaft bearing	Ⓐ:	47.000 - 47.025 (1.8504 - 1.8514)	—
	Ⓑ:	42.500 - 42.525 (1.6732 - 1.6742)	—
	Ⓒ:	48.000 - 48.025 (1.8898 - 1.8907)	—
Outer diameter of camshaft journal	Ⓐ:	46.920 - 46.940 (1.8472 - 1.8480)	—
	Ⓑ:	42.420 - 42.440 (1.6701 - 1.6709)	—
	Ⓒ:	47.920 - 47.940 (1.8866 - 1.8874)	—
Camshaft runout [TIR*]		Less than 0.04 (0.0016)	0.1 (0.004)
Camshaft end play		0.03 - 0.06 (0.0012 - 0.0024)	—



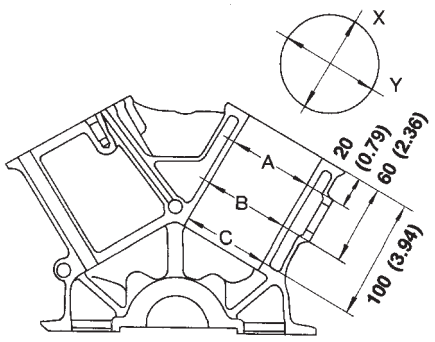
EM671

Cam height "A"	
Intake	39.242 - 39.432 (1.5450 - 1.5524)
Exhaust	38.943 - 39.133 (1.5332 - 1.5407)
Wear limit of cam height	0.15 (0.0059)

*Total indicator reading

CYLINDER BLOCK

Unit: mm (in)



SEM321A

Surface flatness	
Limit	0.10 (0.0039)
Cylinder bore	
Inner diameter	
Standard (No. 1, No. 2 and No. 6 cylinders)	
Grade No. 1	91.500 - 91.510 (3.6024 - 3.6027)
Grade No. 2	91.510 - 91.520 (3.6027 - 3.6031)
Grade No. 3	91.520 - 91.530 (3.6031 - 3.6035)
Standard (No. 3 and No. 4 cylinders)	
Grade No. 1	91.500 - 91.505 (3.6024 - 3.6026)
Grade No. 2	91.505 - 91.510 (3.6026 - 3.6027)
Grade No. 3	91.510 - 91.515 (3.6027 - 3.6029)
Grade No. 4	91.515 - 91.520 (3.6029 - 3.6031)
Grade No. 5	91.520 - 91.525 (3.6031 - 3.6033)
Grade No. 6	91.525 - 91.530 (3.6033 - 3.6035)
Standard (No. 5 cylinder)	
Grade No. 1	91.515 - 91.520 (3.6029 - 3.6031)
Grade No. 2	91.520 - 91.525 (3.6031 - 3.6033)
Grade No. 3	91.525 - 91.530 (3.6033 - 3.6035)
Grade No. 4	91.530 - 91.535 (3.6035 - 3.6037)
Grade No. 5	91.535 - 91.540 (3.6037 - 3.6039)
Grade No. 6	91.540 - 91.545 (3.6039 - 3.6041)
Wear limit	0.20 (0.0079)
Out-of-round (difference between X and Y)	Less than 0.015 (0.0006)
Taper (difference between A and C)	Less than 0.015 (0.0006)
Main journal inner diameter	
No. 1 main journal	
Grade No. 3	66.645 - 66.651 (2.6238 - 2.6240)
Grade No. 4	66.651 - 66.657 (2.6240 - 2.6243)
Grade No. 5	66.657 - 66.663 (2.6243 - 2.6245)
Grade No. 6	66.663 - 66.669 (2.6245 - 2.6248)
No. 2, 3 and 4 main journals	
Grade No. 0	66.645 - 66.654 (2.6238 - 2.6242)
Grade No. 1	66.654 - 66.663 (2.6242 - 2.6245)
Grade No. 2	66.663 - 66.672 (2.6245 - 2.6249)
Difference in inner diameter between cylinders	
Standard	Less than 0.05 (0.0020)

CONNECTING ROD

Unit: mm (in)

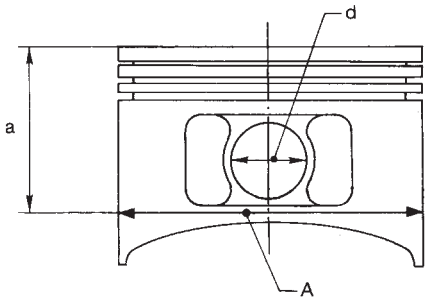
Center distance	154.1 - 154.2 (6.067 - 6.071)
Bend, torsion [per 100 (3.94)]	
Limit	Bend: 0.15 (0.0059) Torsion: 0.30 (0.0118)
Piston pin bushing inner diameter*	20.982 - 20.994 (0.8261 - 0.8265)
Connecting rod big end inner diameter	53.000 - 53.013 (2.0866 - 2.0871)
Side clearance	
Standard	0.20 - 0.35 (0.0079 - 0.0138)
Limit	0.40 (0.0157)

*After installing in connecting rod

PISTON, PISTON RING AND PISTON PIN

Available piston

Unit: mm (in)



SEM804E

Piston skirt diameter "A"	
Standard (No. 1, No. 2 and No. 6 cylinders)	
Grade No. 1	91.465 - 91.475 (3.6010 - 3.6014)
Grade No. 2	91.475 - 91.485 (3.6014 - 3.6018)
Grade No. 3	91.485 - 91.495 (3.6018 - 3.6022)
Standard (No. 3, 4 and 5 cylinders)	
Grade No. 2-1	91.480 - 91.485 (3.6016 - 3.6018)
Grade No. 3-2	91.485 - 91.490 (3.6018 - 3.6020)
Grade No. 3-3	91.490 - 91.495 (3.6020 - 3.6022)
Grade No. 4-4	91.495 - 91.500 (3.6022 - 3.6024)
Grade No. 4-5	91.500 - 91.505 (3.6024 - 3.6026)
Grade No. 5-6	91.505 - 91.510 (3.6026 - 3.6027)
0.25 (0.0098) oversize (Service)	91.715 - 91.745 (3.6108 - 3.6120)
0.50 (0.0197) oversize (Service)	91.965 - 91.995 (3.6207 - 3.6218)
"a" dimension	49.0 (1.929)
Piston pin hole diameter "d"	Grade No. 0 20.969 - 20.975 (0.8255 - 0.8258) Grade No. 1 20.975 - 20.981 (0.8258 - 0.8260)
Piston to cylinder bore clearance	
Standard (No. 1, No. 2 and No. 6 cylinders)	0.025 - 0.045 (0.0010 - 0.0018)
Standard (No. 3 and 4 cylinders)	0.015 - 0.025 (0.0006 - 0.0010)
Standard (No. 5 cylinder)	0.030 - 0.040 (0.0012 - 0.0016)

Piston ring

Unit: mm (in)

	Standard	Limit
Side clearance		
Top	0.024 - 0.076 (0.0009 - 0.0030)	0.11 (0.0043)
2nd	0.030 - 0.070 (0.0012 - 0.0028)	0.1 (0.004)
Oil	0.015 - 0.190 (0.0006 - 0.0075)	—
Ring gap		
Top	0.21 - 0.40 (0.0083 - 0.0157)	0.54 (0.0213)
2nd	0.50 - 0.69 (0.0197 - 0.0272)	0.80 (0.0315)
Oil (rail ring)	0.20 - 0.69 (0.0079 - 0.0272)	0.95 (0.0374)

Piston pin

Unit: mm (in)

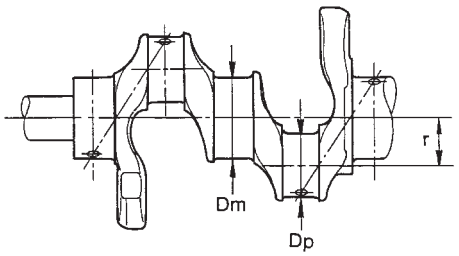
Piston pin outer diameter	20.971 - 20.983 (0.8256 - 0.8261)
Interference fit of piston pin to piston	0 - 0.004 (0 - 0.0002)
Piston pin to connecting rod bushing clearance	
Standard	0.005 - 0.017 (0.0002 - 0.0007)
Limit	0.023 (0.0009)

*Values measured at ambient temperature of 20°C (68°F)

CRANKSHAFT

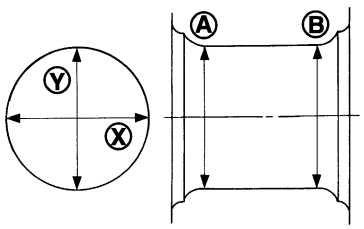
Unit: mm (in)

Main journal dia. "Dm"	
No. 1 main journal	
Grade No. 3	62.969 - 62.975 (2.4791 - 2.4793)
Grade No. 4	62.963 - 62.969 (2.4789 - 2.4791)
Grade No. 5	62.957 - 62.963 (2.4786 - 2.4789)
Grade No. 6	62.951 - 62.957 (2.4784 - 2.4786)
No. 2, 3 and 4 main journals	
Grade No. 0	62.967 - 62.975 (2.4790 - 2.4793)
Grade No. 1	62.959 - 62.967 (2.4787 - 2.4790)
Grade No. 2	62.951 - 62.959 (2.4784 - 2.4787)
Pin journal dia. "Dp"	49.955 - 49.974 (1.9667 - 1.9675)
Center distance "r"	41.5 (1.634)
Out-of-round (difference between X and Y)	
Standard	Less than 0.005 (0.0002)
Taper (difference between A and B)	
Standard	Less than 0.005 (0.0002)
Runout [TIR]	
Standard	Less than 0.025 (0.0010)
Limit	Less than 0.10 (0.0039)
Free end play	
Standard	0.050 - 0.170 (0.0020 - 0.0067)
Limit	0.30 (0.0118)



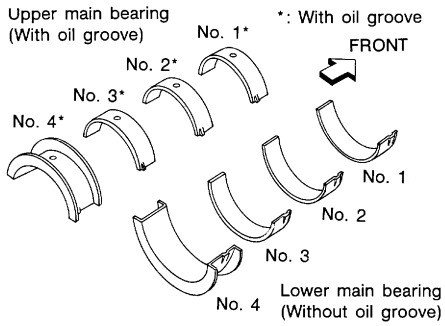
SEM645

Out-of-round: Difference between Ⓧ and Ⓨ
Taper: Difference between Ⓐ and Ⓑ



SEM715-A

AVAILABLE MAIN BEARING



SEM327A

No. 1 main bearing

Grade number	Thickness "T" mm (in)	Width "W" mm (in)	Identification color (mark)
0	1.822 - 1.825 (0.0717 - 0.0719)		Black (A)
1	1.825 - 1.828 (0.0719 - 0.0720)		Brown (B)
2	1.828 - 1.831 (0.0720 - 0.0721)		Green (C)
3	1.831 - 1.834 (0.0721 - 0.0722)	22.4 - 22.6 (0.882 - 0.890)	Yellow (D)
4	1.834 - 1.837 (0.0722 - 0.0723)		Blue (E)
5	1.837 - 1.840 (0.0723 - 0.0724)		Pink (F)
6	1.840 - 1.843 (0.0724 - 0.0726)		Purple (G)

No. 2 and 3 main bearing

Grade number	Thickness "T" mm (in)	Width "W" mm (in)	Identification color
0	1.817 - 1.821 (0.0715 - 0.0717)		Black
1	1.821 - 1.825 (0.0717 - 0.0719)		Brown
2	1.825 - 1.829 (0.0719 - 0.0720)	18.9 - 19.1 (0.744 - 0.752)	Green
3	1.829 - 1.833 (0.0720 - 0.0722)		Yellow
4	1.833 - 1.837 (0.0722 - 0.0723)		Blue

Inspection and Adjustment (Cont'd)

No. 4 main bearing

Grade number	Thickness "T" mm (in)	Identification color
0	1.817 - 1.821 (0.0715 - 0.0717)	Black
1	1.821 - 1.825 (0.0717 - 0.0719)	Brown
2	1.825 - 1.829 (0.0719 - 0.0720)	Green
3	1.829 - 1.833 (0.0720 - 0.0722)	Yellow
4	1.833 - 1.837 (0.0722 - 0.0723)	Blue

Main bearing 0.25 mm (0.0098 in) undersize

Unit: mm (in)

Thickness "T"	No. 1 main bearing	1.956 - 1.962 (0.0770 - 0.0772)
	No. 2, 3 and No. 4 main bearings	1.948 - 1.956 (0.0767 - 0.0770)

Bearing clearance

Unit: mm (in)

Main bearing clearance	
No. 1 bearing	
Standard	0.030 - 0.048 (0.0012 - 0.0019)
Limit	0.060 (0.0024)
No. 2, 3 and No. 4 bearings	
Standard	0.038 - 0.065 (0.0015 - 0.0026)
Limit	0.080 (0.0031)
Connecting rod bearing clearance	
Standard	0.014 - 0.054 (0.0006 - 0.0021)
Limit	0.090 (0.0035)

AVAILABLE CONNECTING ROD BEARING

Connecting rod bearing undersize

Unit: mm (in)

	Thickness	Crank pin journal diameter "Dp"
Standard	1.502 - 1.506 (0.0591 - 0.0593)	49.961 - 49.974 (1.9670 - 1.9675)
Undersize		
0.08 (0.0031)	1.542 - 1.546 (0.0607 - 0.0609)	Grind so that bearing clearance is the specified value.
0.12 (0.0047)	1.562 - 1.566 (0.0615 - 0.0617)	
0.25 (0.0098)	1.627 - 1.631 (0.0641 - 0.0642)	

MISCELLANEOUS COMPONENTS

Unit: mm (in)

Flywheel/Drive plate	
Runout [TIR]	Less than 0.15 (0.0059)
Camshaft sprocket	
Runout [TIR]	Less than 0.1 (0.004)